THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

VIRES·ACQUIRIT·EUNDO

AUGUST 1954

THE INSTITUTION OF

PRODUCTION ENGINEERS JOURNAL

10 CHESTERFIELD STREET . LONDON . W1 Telephone: GROsvenor 5254/9

Vol. 33, No. 8 *Price 10/-* *August 1954*

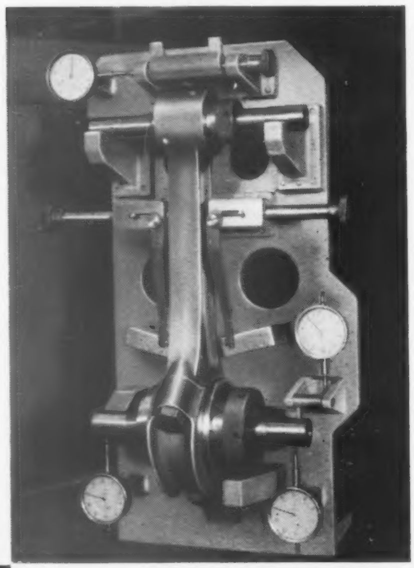
CONTENTS


GRIPPING POWER UP...COSTS DOWN
4 TIMES THE GRIP
HERBERT No 3A
The New
BURNERD
POWERGRIP
HYDRAULIC CHUCKS
SAFELY FIRST
OPTIMUM GRIPPING POWER ENSURES TREMENDOUS CUTTING CAPACITY AT UNLIMITED SPINDLE SPEEDS!!!
Do not limit your machine output by using outmoded chucking equipment
THE SOLUTION TO RAPID, HIGH POWER CHUCKING • ASK FOR COMPLETE DETAILS TODAY
F. BURNERD & CO. LTD., KIDBROOKE PARK RD., LONDON, S.E.3. Phone: Lee Green 3326/7

more gripping power-

PERFECT CONCENTRICITY

MSE "Perfect Grip" expanding Arbors, Mandrels and Chucks use a new principle for gripping cylindrical surfaces. This incorporates a roller grip system which can be applied either internally or externally. Due to this design wear is negligible, only a small applied force gives exceptionally powerful clamping, and loading and unloading are simple and quick. Above all, concentric accuracy is of the highest order, superior to any other method. These clamping tools are used for components or cutters, machining or inspection. There is a wide range of types and sizes of standard Chucks, Arbors and Mandrels; specials for incorporating in fixtures are designed on request. Ask for publication 770.

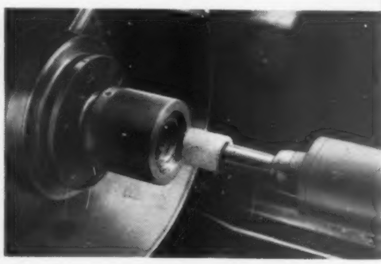


'Perfect Grip' mandrels *used on inspection of connecting rods.*

'Perfect Grip' flanged arbor *used for holding counterweight in the off-centre bore, for finish grinding of main bore. The small internal grinding wheel, mounted on a cylindrical shank, is held in a* **'Perfect Grip' chuck.**

A 'Perfect Grip' flanged chuck *holding a bush for internal grinding.*

The small internal grinding wheel mounted on a cylindrical shank is held in a **'Perfect Grip' chuck.**



MACHINE SHOP EQUIPMENT LTD., SPENSER STREET, LONDON, S.W.I

TELEPHONE: VICtoria 6086

Canadian M.S.E. Ltd., 171, Kipling Avenue South, Toronto 18, Ontario. | M.S.E. Australia) Pty, Ltd., 354, Lonsdale Street, Melbourne, C.I

T.A.6443


A few types of
"PRECIMAX"
PRECISION
GRINDING MACHINES
AND
FINE BORERS
BORING HEADS
Ball Bearing
Plain Bearing
FORM
WHEEL TRUING
ATTACHMENT
Hydraulically
Operated
JOHN LUND LTD.
EASTBURN WORKS, CROSS HILLS, nr. KEIGHLEY
Telephones: 3211-3212-3213 Cross Hills
Telegrams: "Grinding, Crosshills."


Now with
AUTOMATIC
SEQUENCE CONTROL
+GF+
AUTOMATIC
COPYING LATHES
AUTOMATIC Sequence Control, together with
AUTOMATIC Spindle Start and Stop and
AUTOMATIC Spindle Speed Change.
SIDNEY JONES
8 BALHAM HILL · LONDON · S.W.12 · BATTERSEA 3246


MILLS
LEDLOY STEELS
Greatly Improve Repetition Work!
Our experts will be pleased to advise you. Supplied to Admiralty, Air Ministry and many other official specifications.
MILLS LEDLOY Bright Steel Bars are supplied in a wide size range of Flats, Squares, Hexagons, Rounds and Special Sections.
They contain a small percentage of lead, giving greatly improved machining properties to such qualities as Freecutting, Casehardening, Carbon, Heat-Treated Carbon and Alloy Steels without impairing their physical properties in any way.
Experience has shown that MILLS LEDLOY steels give an increase in production from 20% to 100%.
One or all the following advantages can be obtained:
INCREASED FEED
INCREASED TOOL LIFE
INCREASED CUTTING SPEED
INCREASED PRODUCTIVITY
EXORS. OF JAMES MILLS LTD.
BREDBURY STEEL WORKS
WOODLEY · NEAR STOCKPORT · ENGLAND
Telephone: WOODLEY 2231 (10 lines)
Telegrams: "MILLS" PHONE WOODLEY

The Institution of Production Engineers Journal
VOL. 33 No. 8 AUGUST, 1954

A Tale of Three Exhibitions

by Sir WALTER PUCKEY, M.I.Prod.E., F.I.I.A.,
President of the Institution.

THIS of necessity must be a summary of the impressions gained at the last three exhibitions I have attended, each having a common theme and objective —better industrial productivity. Let me give the titles and dates :-

1. INDUSTRIAL EXPOSITION, organised by the American Society of Tool Engineers, Philadelphia, U.S.A., 26th/30th April, 1954.
2. THE GAUGE & TOOL EXHIBITION, organised by the Gauge and Toolmakers Association, New Horticultural Hall, London, 17th/28th May, 1954.
3. THE PRODUCTION EXHIBITION, organised by Andry Montgomery, Ltd., and the Institution of Production Engineers, Olympia, London, 7th/14th July, 1954.

The A.S.T.E. Industrial Exposition

Many members will know that resulting from an imaginative approach some years ago by a past Chairman of Council, Mr. E. W. Hancock, M.B.E., close contact has been maintained between our Institution and the American Society of Tool Engineers. The A.S.T.E. is an influential American professional body having a membership of nearly 25,000, with many active "Chapters" over the whole of U.S.A. and Eastern Canada. It conducts its affairs in much the same way as any other professional body. One essential difference, however, is that every second year it organises what is regarded as one of the most comprehensive displays of industrial metal-working equipment in the U.S.A. The organisers tell me that this Exhibition has grown rapidly in recent years, and I was very impressed by the comprehensive nature of the equipment displayed.

Let us look at a few statistics. The number of firms exhibiting was 548, and at the very well-attended conference held in conjunction with the Exhibition, 54 technical papers, many of a very high standard, were presented to large and appreciative audiences.* These statistics are impressive, and the choice of equipment on show was almost embarrassing to the visitor.

I was very impressed by the attendance and the degree of enthusiasm shown by most of those attending. The U.S.A. is a large country and it always impresses me to read on the label that is inevitably worn by those attending American conferences that the owner has travelled possibly 3,000 miles to attend. The fact that 7,000 to 8,000 people turned up each day, many from a great distance, speaks well for the enthusiasm of A.S.T.E. members. A similar enthusiasm was noticed at the conference sessions. I was struck, too, by the relative youth of those attending, and I formed the impression that they had not found it difficult to persuade their superiors that a long trip to Philadelphia for a few days was a justifiable company investment.

Many members will know that each incoming President of the A.S.T.E. automatically becomes an Honorary Member of the Institution of Production Engineers, and it was my pleasure and privilege at the Annual Banquet held during the Exhibition to hand over the certificate of membership to the incoming President, Mr. Joseph P. Crosby. Nothing could have given me greater pleasure, too, than being presented by the retiring President, Mr. Roger F. Waindle, with a framed certificate of membership of the A.S.T.E., and being invited to say a few words to those present on the relationships between our two bodies.

* See page 479 of this Journal.

ST.

This Annual Banquet was in itself an interesting and impressive occasion. It was extremely well attended, and before dinner commenced the Secretary, Mr. H. E. Conrad, introduced the principal officers and guests to the assembled gathering. After-dinner speeches were few and to the point, the principal one being given by a distinguished representative of the American educational world, who spoke on the need for more and better education in the technological world of the future.

Altogether, my official visit to Philadelphia was one of great interest and inspiration, and I am grateful to our sister Institution overseas for the hospitality and courtesy extended to me as a representative of our members.

The Gauge and Tool Exhibition

Within a few days of my return home I was able to visit the Gauge and Tool Exhibition and found, as I expected, almost exactly the same sort of equipment on show to achieve approximately the same end results. As is to be expected, this Exhibition was very much smaller than its American counterpart, and the number of firms exhibiting was approximately 90 against 548 at Philadelphia. As is usual with this Exhibition, no conference was held in conjunction with it.

It is difficult to make useful comparisons when there is such a marked difference in size and venue. The average age of those attending the London Exhibition appeared to be several years greater than at Philadelphia. I had the impression, too, that there was much less bustle and interest around the various stands.

Many of us have admired greatly the energetic work of the G.T.M.A. and as I am not personally a member of that body I can give no more than an outside impression of the Exhibition. It may be that the organisers are well satisfied with the growth of the Exhibition and they certainly have great reason to be satisfied with the production and export achievements of the gauge and tool industry, which has, I think, done a remarkable job, particularly during the last few years when it has had to bear the burdens of a defence programme and at the same time has built up its regular home and export business. One does, however, have the feeling that its national shop window could be even more comprehensive and ambitious and, taking size alone as a basis of comparison, we might assume that the number of future exhibitors could well be doubled, and that the display of equipment could be even more comprehensive.

What about the equipment on view at these two Exhibitions? I have not attempted to get out precise statistics, but the general impression I formed at both Exhibitions was that there was a noticeable increase in what one might call "quality control" equipment, that is, the means of measuring and controlling ever more precise dimensions. This is very logical and in line with production engineering trends, where, arising from the demand for greater performance by designers and from the need to build more controls into the production line, there is an ever greater demand for control equipment, which not only anticipates trouble but is very often so hooked up that it can correct trouble by 'feed-back' instructions. The use of greater amounts of ancillary equipment is noticeable in the output statistics of, let us say, the machine tool and the gauge and tool industries, which emphasises the relatively greater expenditure being incurred on equipment in relation to capital investment in the machines themselves. While this is undoubtedly a healthy sign if it enables more and better work to be produced from the machines, it emphasises one real danger, and that is that we may find the choice of ancillary equipment so wide and varied that the integration of this equipment with the machine itself may become much more difficult.

We all remember the motor car of 20 years ago which was adorned by the enthusiastic owner with a variety of new gadgets, finally giving a Christmas-tree effect. This trend, I believe, is noticeable today in the machine tool world, and the time is coming when the fuller integration of the machine with its ever wider group of ancillary equipment must be considered in greater detail.

Part of that consideration must be given to the best forms of exhibiting both the machine and the equipment which can be used in conjunction with it, and it was very noticeable in both Philadelphia and London that we had a great deal of equipment on show but very few machine tools. This is not the place to enter into a controversial field of exhibition policy, but it is fairly well-known that in this country there are difficulties standing in the way of joint exhibition endeavour

(*continued on page* 479)

SIMPLIFICATION BY SELECTION

by H. G. CONWAY,

M.A., F.R.Ae.S., M.I.Mech.E.

Born in 1914, Mr. Conway was educated at Cambridge University. In 1939 he was appointed Chief Engineer of Messier Aircraft Equipment, Limited, subsequently joining the Dunlop Rubber Company, Limited, in 1945, as Chief Engineer of the Aviation Division.

Two years later, Mr. Conway became Technical Director of British Messier, Limited, where he remained until taking up, this year, his present appointment as Chief Engineer of Short Bros. & Harland, Limited.

Mr. H. G. Conway

THIS Paper discusses the processes of engineering standardisation, with particular reference to the possibilities of achieving desirable objectives by preferential selection from existing productions, in addition to the more straightforward technique of creating new Standards. As far as possible practical examples of good and bad practice will be quoted in preference to generalised statements.

The following quotation from a contributor in "Wireless World" of May, 1954—appropriately enough headed "Running Riot?"—expresses the feelings of many engineers on similar states of affairs in different spheres:

"The note in the April issue of the 'Wireless World' on the latest edition of the British Standard on valve bases frankly horrified me. That BS.448 : 1953 should have to include at least twenty-five types of British valve bases is surely a rather awful thing. We seem to be getting farther and farther from any kind of rationalisation and the existence of this unconscionable number of different valve bases can't be doing anybody (including those who make them) very much good. It can lead only to needlessly high costs, to waste of time and to other far from desirable consequences in the assembly and maintenance of electronic gear. Here, certainly, is a problem that should be tackled without delay".

Note that this criticism is directed against industry rather than at the British Standards Institution, who have strictly limited power to oppose industry in their endeavours to "co-ordinate the efforts of producers and users for the improvement, standardisation and simplification of engineering and industrial materials".

The two main methods by which national standardisation has been achieved in the past (and probably will continue to be achieved in the future) are, firstly, by the activities of a standardisation body such as the B.S.I., and secondly by a "Darwinian" process of the survival of the fittest. Industrial power, and sometimes the enterprise of a smaller unit, have often created new features or products which have eventually been followed and adopted in part as Standards by other makers; examples of this process are the Yale Lock key, Morse Tapers, or the

ELECTRIC LAMPS

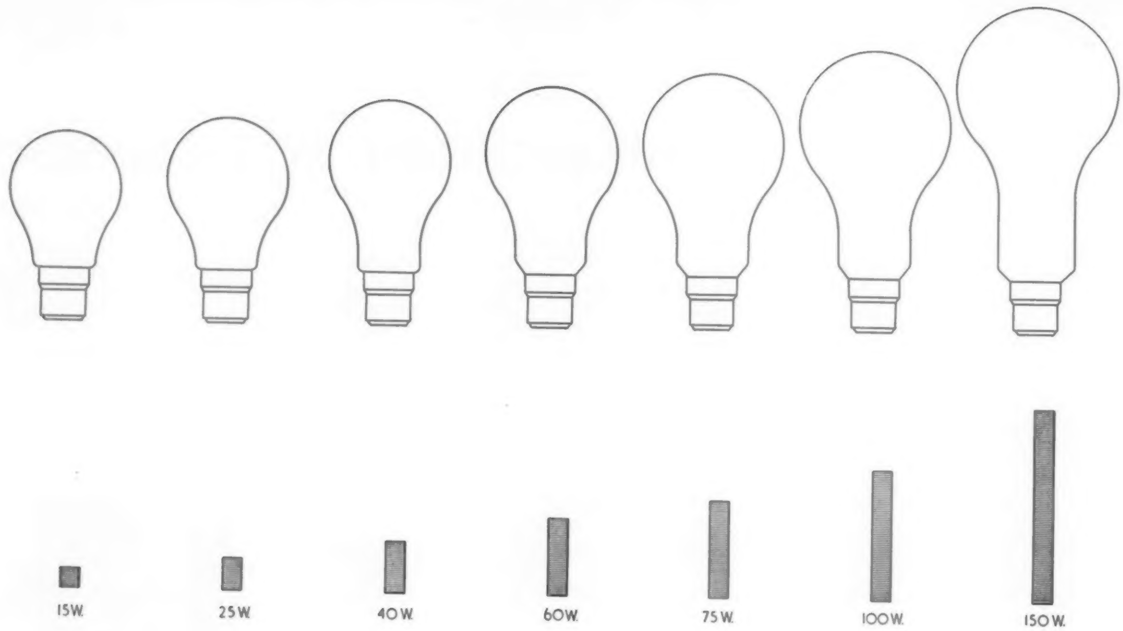


Fig. 1. The Power of Electric Lamps.

TABLE I. COMPARATIVE FILM SPEED RATINGS

B.S.I. and A.S.A. Arithmetic	B.S.I. and A.S.A. Logarithmic	D I N	G.E.C.	WESTON	ILFORD	KODAK and SCHEINER	WELLCOME
6	19	10/10	8	5	B	20	
8	20	11/10	10	6		21	1/8
10	21	12/10	12	8		22	
12	22	13/10	16	10	C	23	
16	23	14/10	20	12		24	1/16
20	24	15/10	24	16		25	
24	25	16/10	32	20	D	26	
32	26	17/10	40	24		27	1/32
40	27	18/10	48	32		28	
48	28	19/10	64	40	E	29	
64	29	20/10	80	50		30	1/64
80	30	21/10	100	64		31	
100	31	22/10	125	80	F	32	
125	32	23/10	160	100		33	1/128
160	33	24/10	200	125		34	
200	34	25/10	250	160	G	35	

NOTE: (a) Close similarity of B.S.I. Arithmetic, G.E.C. and Weston, each using a Preferred Number type of series.

(b) D I N and Scheiner are identical but expressed differently.

(c) B.S.I. Logarithmic is identical with D I N and Scheiner less 1 degree.

(d) Other older systems which are still sometimes encountered include H & D, American Scheiner, Smethurst, Watkins, Wynne, etc.

cavity in the modern British car's dashboard designed to take a particular make of radio.

If the large units of industry have a heavy responsibility to the country as a whole—and many of them bear it conscientiously—to adopt British Standards, they have an equally heavy responsibility to the public itself not to create arbitrary standards of their own at the expense of that public, merely out of a lack of magnanimity which prevents them co-operating with other firms at an early stage.

The most remarkable example which the author can call to mind of industrial stupidity (on an international scale) at the expense of every humble snapshot-taker or photographer is illustrated in Table I. This reproduces a section of the sort of table of comparative film speed ratings which the photographer must refer to when dealing with different makes of films or exposure meters, or reading reference books. While there is some excuse for international differences, only Germany has a unified national system; in Britain and U.S.A. the larger film and exposure meter makers have their own individual systems. To make matters worse, the newer A.S.A. and B.S.I. systems (happily the same with different titles) have created not one new series but two—arithmetic and logarithmic. The ordinary photographer can be excused for thinking that he has not been fairly treated by industry. Preferential Selection by those formulating the Standard could have avoided these difficulties.

The Standardisation Process

Standards for ranges of products or components are prepared by a variety of methods, ranging from the use of theoretically desirable series to the adoption of those which have grown up out of practical convenience. Examples of regular and theoretically good ranges are the power of electric lamps (Fig. 1) and the new Hook Spanners in BS.2090 (Fig. 2). Examples of series of products which have "grown-up" out of industrial convenience are Philips Photoflux flash lamps (Fig. 3) and Herbert Capstan lathes (Fig. 4).

National characteristics seem to be evident in this field. French and German liking for theoretical perfection is seen in the wide use of theoretical bases, including the use of the Preferred Numbers referred to below. The American practical approach and the comparative independence of the larger American Corporations are noticed in the few national Standards and the many independent trade Standards in that country; indeed the number of anomalies in American Standards is surprising—a simple example is the multiplicity (by British standards unnecessary) of bolt and nut hexagons (Fig. 5). In Britain we like to feel that we have reduced compromise in this as in other spheres to an art; it is probably true that we have the best set of industrial standards of any country.

The achieving of satisfactory standards is in itself something of an art, or at least a job which has to be learnt. The present author has been fortunate in being able to observe the process both in this country, in America and on the Continent. Undoubtedly to understand what happens at standardisation meetings, a knowledge of human nature and elementary psychology is needed. And the psychology of the English engineer is certainly quite different to the psychology of other delegates to international meetings. The same partisan behaviour, national conceits, fear of giving too much ground and, indeed, lack of comprehension of what other delegates do mean by their speeches, are as evident at international Standards meetings as they are at political or cultural meetings. Only when committees have met several times and the delegates become friends are really good Standards likely to be agreed.

It is important that those who have to make use of Standards later should understand the practical difficulties in drawing them up. Usually the production engineer in a factory is quite content with the Standard he already has and is reluctant to adopt the new one just published, say, by the B.S.I. For example, a recent letter in the "Engineer" begins:

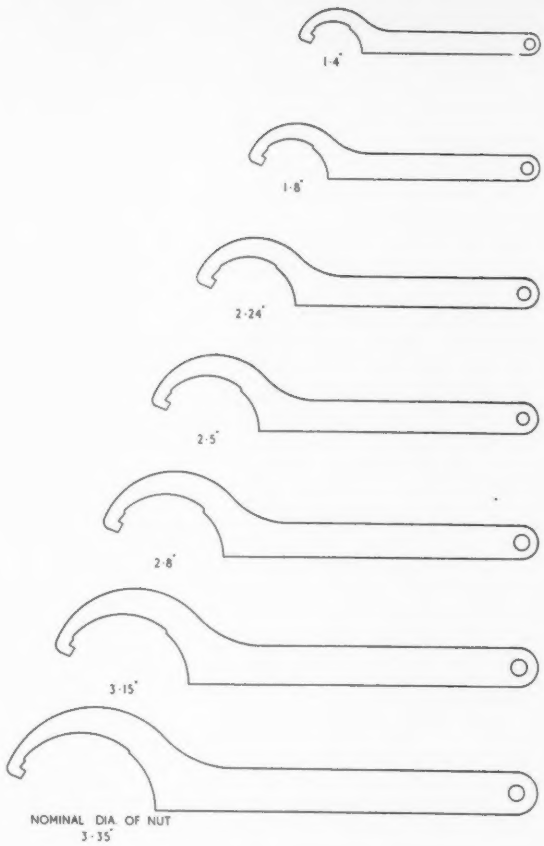


Fig. 2. Hook Spanners to BS.2090.

(R20 Preferred Numbers).

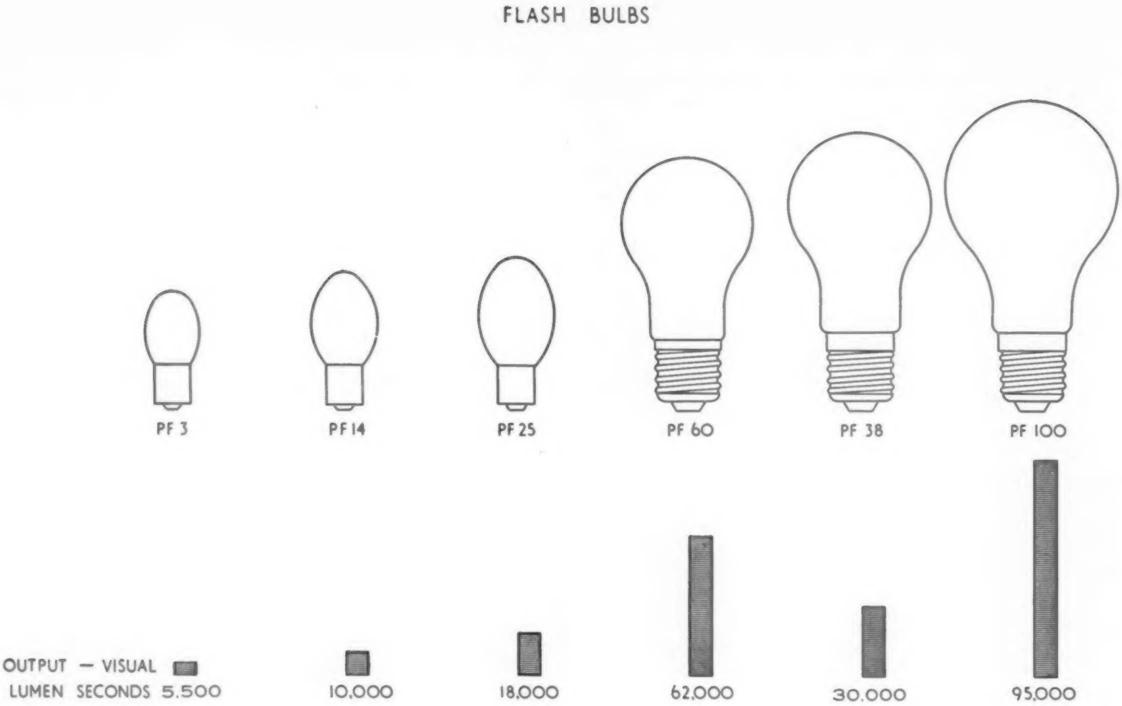


Fig. 3. Philips Photoflux Flash Lamps.

"It would be interesting to know why it was considered necessary to produce a B.S.I. Standard for the Unified Thread. The potted history in BS.1580-1949 makes it quite clear that whatever the British representatives suggested at the various meetings was met with a blunt rejection". Later, the correspondent makes the extraordinary statement that we are scrapping "the finest screw thread system in the world in favour of a poor imitation of it which was introduced solely to be non-interchangeable with the Whitworth system".

Many production engineers in Britain have in fact been disturbed by the recent publication of the Unified Thread. The following questions have probably been asked by thousands of British engineers; and if the brief answers given now are truthful, they are not necessarily as convincing on the shop floor as around the table at an international conference :

Q. Why do we have to have a Unified Thread; what is wrong with the Whitworth Thread ?

A. There is nothing wrong with the Whitworth Thread. We have to adopt an American thread (the Unified is really an American thread) because Anglo-American Standardisation is vital to defence and desirable for export trade, and because we can't expect Americans with their larger industrial investment to change to Whitworth.

Q. So we are in fact making all the sacrifices ?

A. Yes; as the smaller partner, this is inevitable.

Q. What about the rest of the Specification of the thread; is this all American too ?

A. No. The B.S.I. played a large part in settling new tolerances and allowances for the threads. They are technically better and easier to produce than our older Standards.

Q. So we are landed with having to stock screwing tackle for Whitworth and B.S.F. threads as well as the new Unified Coarse and Fine for many years to come. Won't this enormously increase our tool costs ?

A. The position need not be as bad as this. Many firms make use of Whitworth threads for certain classes of work (e.g. maintenance) and B.S.F. in their products. They could use B.S.F. exclusively. Thus they should concentrate on adopting Unified Fine exclusively. Tool costs are not as bad as you make out, as screwing tackle is a consumable item, and the *overall* usage should remain the same even if the variety is greater in the intervening period of overlap.

There is no doubt, however, that the adoption of new Standards can be greatly facilitated by the Ministry of Supply demanding their use on defence contracts. Once forced into use, new Standards

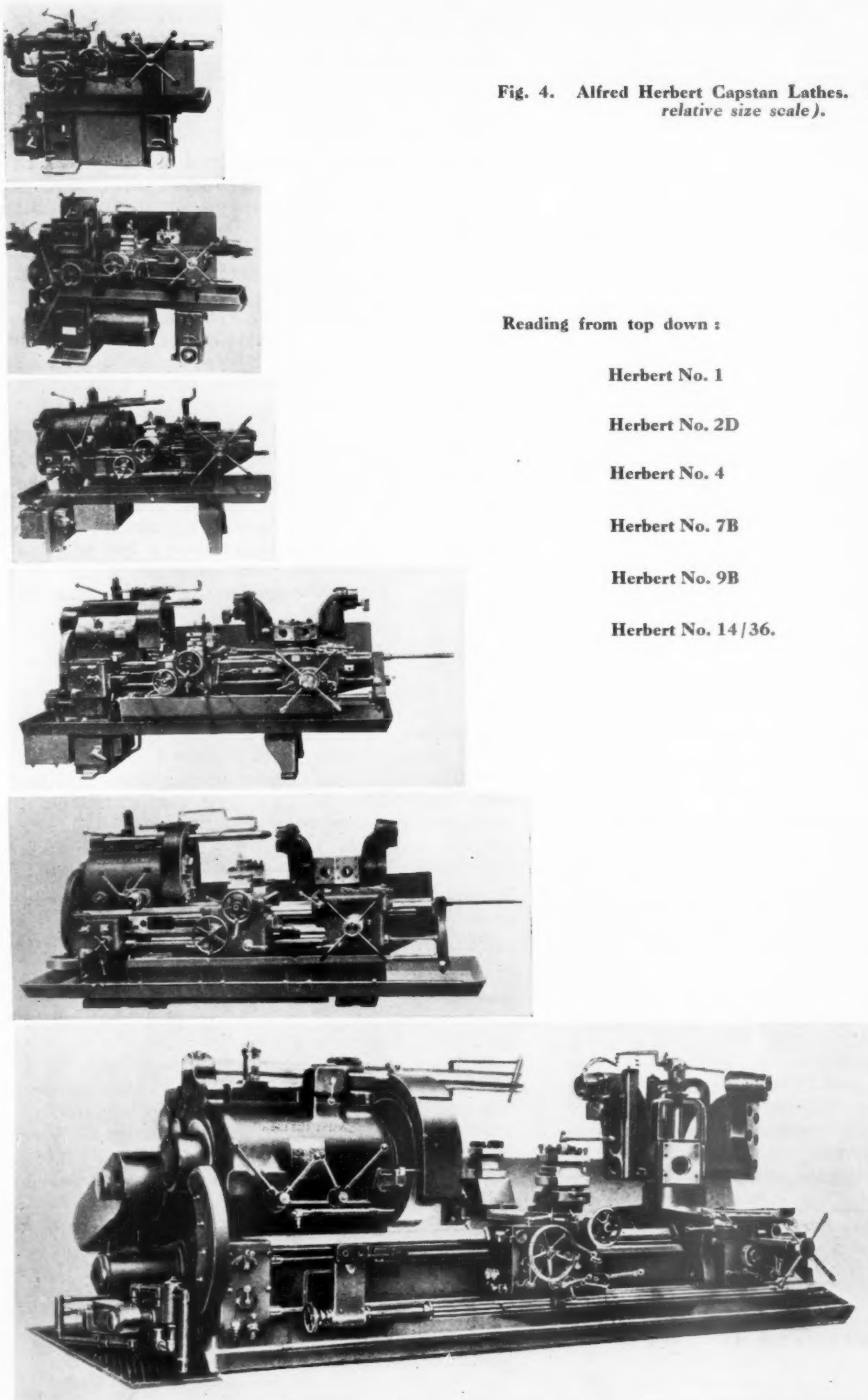


Fig. 4. Alfred Herbert Capstan Lathes. ***(Illustrated in relative size scale).***

Reading from top down :

Herbert No. 1

Herbert No. 2D

Herbert No. 4

Herbert No. 7B

Herbert No. 9B

Herbert No. 14/36.

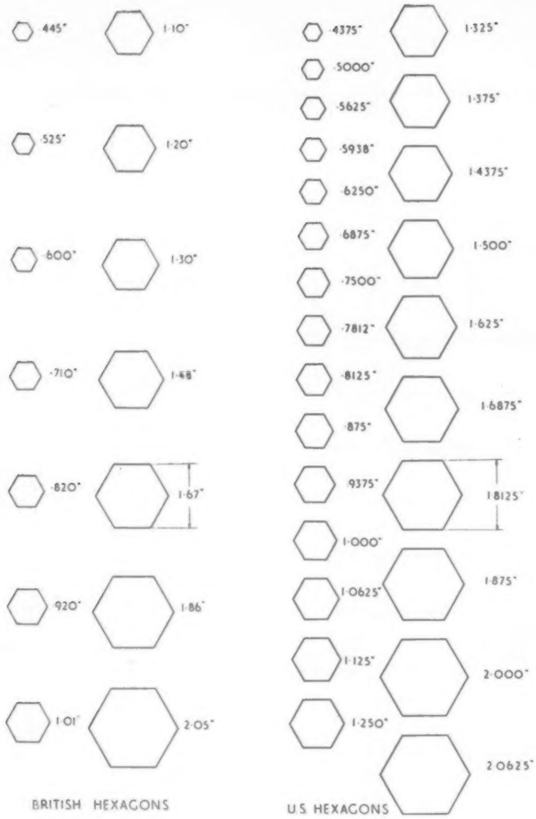


Fig. 5. British and American Hexagon Sizes.

which have been properly prepared by experts are invariably found to be quite acceptable to production engineers; their often quite natural hostility is soon forgotten.

Standards, to be effective, need not be too simple. If the lack of uniformity in electric lamp voltages in Britain (200, 210, 220, 230, 240, 250 volts) is irritating and unreasonable, the existence of two Standard voltages (6 and 12 volts) in the automobile industry is not. Two voltages here are technically desirable, the lower for economy and the higher for performance; certainly many American cars would be better with 12 volt systems and indeed there is a trend in the U.S.A. in that direction. Perhaps the lack of a second Standard has been a brake to technical progress there.

Preparing a Standard

As an illustration of the process of thought which takes place in arriving at a product which requires Standardisation, imagine for example that a firm has designed a new type of container for water, oil, acid, etc., to be produced, let us say, by some new technique such as in glass fibre plastic. The original experimental design is produced in, say, a 5 gallon size as being a common requirement. The firm then finds a demand for a larger size and produces a 10 gallon version, the step of 2 being a usual one for an engineer to take. Logically the series 5–10 can be developed along two lines:

Arithmetic: – 5 – 10 – 15 – 20 – 25 – 30 etc.
Geometric: – 5 – 10 – 20 – 40 – 80 etc.

In practice, what will probably happen is that the firm finds after a few years that its catalogue lists a mixed series which has grown up around special demands and requirements, or even a few mistakes which when corrected gave undersize or oversize capacities. The catalogue series might read as follows:-

$\frac{1}{2}$, $\frac{3}{4}$, 1, 1.5, 2, 2.25, 4, 4.5, 5, 6, 6.75, 8, 9, 10, 10.5, 11, 12, 12.5, 15, 16, 18, 20.

By this time the firm will have realised that it is a pity it had not thought the matter out initially and had prepared a basis for a Standard before starting. If it were not familiar with Preferred Numbers (see below), it might have decided upon a series of arithmetic progressions (which indeed closely resemble a true geometric progression), for example:

$\frac{1}{2}$, $\frac{3}{4}$, 1 – $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3 – 4, 5, 6, – 8, 10, 12, – 16, 20
($\frac{1}{4}$ step) ($\frac{1}{2}$ step) (1 step) (2 step) (4 step)

Familiarity with Preferred Numbers, however, would probably have given the following series:

0.63, 0.8, 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3, 8, 10, 12.5, 16, 20.

(If rounded Preferred Numbers were used—see below—the values 0.6, 3, and 6 would replace those quoted).

However, the firm in question finds itself in a difficult position and wants to rationalise the catalogue list as much as possible by eliminating some sizes, but retaining existing production types as far as possible.

A good approximation to the desirable Preferred series can be derived as follows:-

Catalogue Series:

$\frac{1}{2}$, $\frac{3}{4}$, 1, 1.5, 2, 2.5, 4, 4.5, 5, 10.5, 11, 12, 12.5, 15, 16, 18, 20

Preferred Numbers:

0.63, 0.8, 1, 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6, 6.75, 8, 9, 10, 12.5, 16, 20.

Final Compromise:

$\frac{1}{2}$, $\frac{3}{4}$, 1, 1.25, 1.5, 2, 2.5, 3, 4, 5, 6.3, 8, 10, 12.5, 16, 20.

TABLE II. PRINCIPAL SERIES OF PREFERRED NUMBERS

Principal series				Serial number	Basic Logarithm	Calculated values	Percentage differences between principal series and calculated values
R5	**R10**	**R20**	**R40**				
1.00	1.00	1.00	1.00	0	000	1.0000	0
			1.06	1	025	1.0593	+0.07
		1.12	1.12	2	050	1.1220	—0.18
			1.18	3	075	1.1885	—0.71
	1.25	1.25	1.25	4	100	1.2589	—0.71
			1.32	5	125	1.3335	—1.01
		1.40	1.40	6	150	1.4125	—0.88
			1.50	7	175	1.4962	+0.25
1.60	1.60	1.60	1.60	8	200	1.5849	+0.95
			1.70	9	225	1.6788	+1.26
		1.80	1.80	10	250	1.7783	+1.22
			1.90	11	275	1.8836	+0.87
	2.00	2.00	2.00	12	300	1.9953	+0.24
			2.12	13	325	2.1135	+0.31
		2.24	2.24	14	350	2.2387	+0.06
			2.36	15	375	2.3714	—0.48
2.50	2.50	2.50	2.50	16	400	2.5119	—0.47
			2.65	17	425	2.6607	—0.40
		2.80	2.80	18	450	2.8184	—0.65
			3.00	19	475	2.9854	+0.49
	3.15	3.15	3.15	20	500	3.1623	—0.39
			3.35	21	525	3.3497	+0.01
		3.55	3.55	22	550	3.5481	+0.05
			3.75	23	575	3.7584	—0.22
4.00	4.00	4.00	4.00	24	600	3.9811	+0.47
			4.25	25	625	4.2170	+0.78
		4.50	4.50	26	650	4.4668	+0.74
			4.75	27	675	4.7315	+0.39
	5.00	5.00	5.00	28	700	5.0119	—0.24
			5.30	29	725	5.3088	—0.17
		5.60	5.60	30	750	5.6234	—0.42
			6.00	31	775	5.9566	+0.73
6.30	6.30	6.30	6.30	32	800	6.3096	—0.15
			6.70	33	825	6.6834	+0.25
		7.10	7.10	34	850	7.0795	+0.29
			7.50	35	875	7.4989	+0.01
	8.00	8.00	8.00	36	900	7.9433	+0.71
			8.50	37	925	8.4140	+1.02
		9.00	9.00	38	950	8.9125	+0.98
			9.50	39	975	9.4406	+0.63
10.00	10.00	10.00	10.00	40	000	10.0000	0

The final compromise is arrived at by a mixture of theory and practical common sense, as follows :-

(a) 13 sizes are *selected* from the existing series (9 being rejected).

(b) 3 new sizes (1.25, 2.5, and 3) are added to make the series geometric and consistent throughout. (It is most important to note here that mathematical consistency is not necessarily desirable. It may be that the small steps below 1 gallon—i.e. the $\frac{3}{4}$ and $\frac{1}{2}$ gallon size—may be required to meet some special market demand, and the continuation of the series by the addition of 1.25 and 2.5 may be quite unnecessary).

(c) The rounded values 1.5, 3, and 6 gallons are used to preserve tools (for 1.5 and 6) and out of deference to a public not yet ready to buy 6.3 gallons of a liquid.

(d) 12.5 gallons (a Preferred Number value) is retained in place of 12 because it is an existing production size.

(e) An advantage stemming directly from the use of Standard series is that intermediate or additional sizes can be added or the range extended later on, in a logical manner.

This simple illustration has been given to underline the desirability of prior thought before embarking

on a new production which may lead to substantial scaling up or down, and to show that it may be possible to make a reasonable job of simplifying a range by preferential selection at a later date. In practice of course many other factors have to be considered, although the principle of what has been said can usually at least be borne in mind.

Preferred Numbers

Reference has already been made to " Preferred Numbers " or Renard numbers as they are sometimes known. The first utilisation of preferred numbers took place in France at the end of the 19th century. In 1877-9, Engineer Captain Charles Renard

> "who was studying rationally the elements necessary in the construction of balloons, computed cotton ropes according to a grading system such as would permit them to be manufactured *a priori* without taking into account the type of balloon to which they would be applied. Realising the interest in making use of a geometrical progression, he took as a basis a rope with a mass of " a " grams per metre and as a grading system a law such that, every 5 terms of the series, the same value " a " should be found with an approximation of the multiple of 10 ".

The numbers are thus often known as Renard Numbers, and the various series termed R5, R10, R20, etc. These numbers are merely convenient series of numbers in geometric progression, based on the 5th, 10th, 20th, or 40th roots of 10 (i.e. antilog 1/5, antilog 2/5, antilog 3/5, etc. form the series based on the 5th root of 10). These numbers have been found to have various convenient properties and enable any standard for length, size, weight, power, etc. which is required to be in ascending or descending order of magnitude to be chosen with facility to give step increments of 3, 6, 9, 12, 18, 25, 40, 60 and 100 per cent. (These are the standard percentage increments; others are possible).

Table II (from B.S.2045 :1953, Preferred Numbers) gives the numbers themselves, rounded off from the theoretical values according to agreed International practice. There is an additional series of numbers forming the R80 series. It will be noted that the R5, R10, R20, R40, and R80 series give respectively 60, 25, 12, 6 and 3 per cent. increments; other steps can be derived by using intermediate terms.

It has been found that these numbers can be extraordinarily useful to engineers, who frequently require series of values but rarely are much concerned with the *exact* value of the increment. For example, a step of 60 per cent. can invariably be used for one required to be " about $1\frac{1}{2}$ " (see for example the scaling of tolerance grades in B.S.1916, Limits and Fits). Another common series is that based on 2 (i.e. 1, 2, 4, 8, 16, etc.), and this happens to be a Preferred Number series. It is widely seen, although up to the present with values 32 and 64 in place of the correct 31.5 and 63 (see for example the film speed numbers in Table I, or the well known surface finish quality series 1, 2, 4, 8, 16, etc. micro inches R.M.S.).

Two other properties of these numbers are of interest. The metric inch conversion factor 25.4 corresponds closely to the Preferred Number 25, and thus a Preferred Number series in inches remains *approximately* a Preferred Number series when converted to millimetres, viz :

dimension :	10	16	25	40	63	100 inches
exact conversion :	254	406.4	635	1016	1600.2	2540 m.m.
Preferred Number :	250	400	630	1000	1600	2500
error :	–4	–6.4	–5	–16	–0.2	–40 m.m.

TABLE III
NON-STANDARD ROUNDED PREFERRED NUMBER SERIES

1. **R5 (Rounded) Series**
   10, 15, 25, 40, 60, 100
2. **R10 (Rounded) Series**
   10, 12, 15, 20, 25, 30, 40, 50, 60, 80, 100
3. **R20 (Rounded) Series**
   10, 11, 12.5 (12), 14, 16, 18, 20, 22, 25, 32 (30), 36 (35), 40, 45, 50, 55, 60, 70, 80, 90, 100

(The values in brackets give less regular progressions but may be necessary for some applications.)

In some applications where the manufacturing tolerance is broad, these errors can be ignored (e.g. paper sizes, transmission belt widths, etc.). In many engineering products, however, the errors are obviously unacceptable—hence the failure of some attempts to achieve truly international standardisation of such basic elements as screw threads.

The other useful property of Preferred Numbers is that the ratio π (pi) ($=3.1416$) closely corresponds with the Preferred Number 3.15, and thus calculations involving areas of circles remain closely in Preferred Numbers if the diameter is so expressed (see example below).

As the practical numbers are rounded, the product or division of two or more Preferred Numbers does not exactly result in another Preferred Number. Similarly the addition and subtraction of Preferred Numbers, being logarithmic numbers, do not result in other preferred values. (The Standards Engineer soon gets used to such strange results as $1 + 1.6 = 2.5$ or $4 + 6.3 = 10$).

Rounded Preferred Numbers

The wide adoption of true Renard Numbers has been hampered by a reluctance of many engineers to make full use of some of the more unusual looking numbers such as :

1.12, 2.24, 3.15, 3.55, 5.6, 6.3 and 7.1

Existing practice has also to be taken into account; for example, in metric practice in the range 50 – 80 m.m. the recognised dimensions of bolts, shafts, bearings, etc. are in multiples of 5 m.m. giving a series 55, 60, 65, 70 ...m.m. in place of the Preferred Number series 56, 60, 63, 67 ... Again, the Preferred Number dimension 56 m.m. is perfectly suitable as a normal dimension, but it would be unreasonable to

expect 5.6 to be used for a simple dimension such as the diameter of a drill; obviously 5.5 m.m. would be used instead. However, the number 56 is once more commonly used as a number of microns in a tolerance value, although 5.5 microns would be used in preference to 5.6 microns in a similar application. These examples show that the optimum method of rounding off a Preferred Number may depend on the magnitude of the dimension and existing practice in regard to its use.

Some limited use is often made of rounded series, or strictly, series rounded off more coarsely than the true Preferred Numbers. It is indeed possible that this rounded series will eventually be the subject of international agreement, as there is a great deal to be said for having it as an authorised alternative to the true values; the adoption of the rounded series will pave the way for the eventual use of the true series.

Typical rounded series are given in Table III. The series of multiple 2 referred to above (1, 2, 4, 8, 16, 32, 64, 125, 250, etc.), unfortunately makes use of 64 in place of 63, although understandably has 32 in place of 31.5.

The American Standards Association has published in its American Standard for Preferred Numbers (Z17.1 – 1936) a group of corresponding fractional inch series (e.g. 5/32, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{5}{8}$, 1, $1\frac{1}{2}$, $2\frac{1}{4}$, 4, 6, 10, etc.); these have not found support outside that country, if indeed much support inside it, as the use of fractions seems opposed to the very principle of Renard Numbers.

Examples of the Use of Preferred Numbers

The following examples known to the author may serve to illustrate the practical utility of Preferred Numbers :-

Spanners. The Hook and Peg Spanners given in BS.2090 make use of Preferred Number inch dimensions for the basic fitting diameter of the spanner (Fig. 6).

Cranes. There is a Norwegian Standard for jib cranes quoting the standard tonnage of the cranes as 1, 1.25, 1.6, 2.5 .... 63 tons.

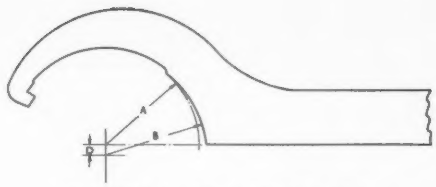
Cutting Tool Shank Diameters. A Dutch Standard lists the widths and thicknesses of the shanks of cutting tools in the series;
4, 5, 6, 8, 10, 12, 16, 20, 25, 32 m.m.

Currents. The publication 59 of the International Electrotechnical Commission gives, for the normal currents, the following values expressed in amperes :

1	1.25	1.6 etc.
10	12.5	16 etc.
100	125	160 etc.
1.000	1.250	1.600 etc.

Speed of Shafting. The French Standard E 22-003 has adopted the following table for shaft rotational speed (r.p.m.).

25	63	160	400	1.000	2.500
31.5	80	200	500	1.250	3.150
40	100	250	630	1.600	
50	125	315	800	2.000	



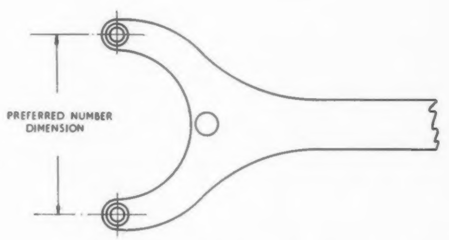


Fig. 6. Hook and Peg Spanners.

Nominal Diameters of Bare Copper Wire. The French Standard C 31-111 has adopted the following values, expressed in m.m.

0.0315	0.071	0.118	0.170
0.0355	0.080	0.125	0.180
0.040	0.090	0.132	0.190
0.050	0.100	0.140	0.200
0.056	0.106	0.150	
0.063	0.112	0.160	

Tanks for Water Under Pressure. The German Standard DIN 2 760 has adopted for the nominal capacities of Tanks under pressure the following values, expressed in litres :

4		6.3		10 etc.
40		63		100 etc.
400	500	630	800	1.000 etc.
4.000	5.000	6.300	8.000	10.000 etc.

Shaft Heights for Driven and Driving Machines. The ISO has adopted Preferred Numbers for the shaft centre heights of certain types of machinery.

Undercuts. The Standard Tools listed in B.S.1936 " Undercuts and Runouts for Screw Threads " have a series of widths as follows :-
0.02, 0.032, 0.04, 0.05, 0.063, 0.08, 0.10, 0.125, 0.16, 0.2, 0.25 in., etc.

Machine Tool Speeds and Feeds. Various proposals have been made on this subject, and Holland has already adopted the R20 series for speeds and feeds. In inch values these would correspond to :-

speeds, r.p.m. 100, 112, 125, 140, 160, 180, 200, 224, 250, etc.
feeds, in. 0.01, 0.011, 0.0125, 0.014, 0.016, 0.018, 0.02, etc.

It would appear more reasonable to use the R10 series for most machines, for example :-

speeds, r.p.m. 100, 125, 160, 200, 250, 315, 400, etc.
feeds, in. 0.01, 0.0125, 0.016, 0.02, 0.025, 0.032, 0.04, etc.

Hydraulic Equipment. A British firm manufacturing hydraulic equipment has standardised cylinder diameters in the R40 series in order to enable a limited range of grinding, honing and gauging equipment to be stocked, to facilitate raw material supply and to enable many internal components, pistons, seals, etc. to be standardised. The comparatively small steps of the R40 series are necessary because the hydraulic load or force involved is a function of area or the square of the diameter increment. (Increment in the R40 series = 6%, or about 12% in area).

The firm uses these diameters in all hydraulic designs, an interesting example being in hydraulic accumulators (piston type). The main technical requirement here is deplaced volume, and units are standardised in the 5 series,(40, 63, 100, 160 ...... etc., cubic inches).

Since Volume $= \pi/4(D\,\pi \times L)$, and because $\pi/4$ is very nearly a standard number, it would be possible to use Preferred Numbers of the piston stroke L as well as diameter D and Volume V. There is no advantage in this, however, and the firm uses exact values of L corresponding to Preferred Number values of D and V.

Tolerance Values. The new British Standard for Limits and Fits (BS.1916) uses Preferred Number tolerance values, as given in Table IV. It will be noted that rounded values are used in several cases; it would obviously be unreasonable to expect an engineer to work to a tolerance of 0.00315 or 0.00063. This Table was only agreed after much negotiation between America, Canada and Britain and is an interesting example of practical expediency — the series is in fact a rounded R20 series with two terms (1.1 and 5.5) omitted. Note also how the series changes from R20 to R10 below 0.0005 in., because the fineness of the steps cannot be of proper significance in this sphere of precision.

Electrical Resistors and Capacitors. The electrical industry has long used a grading system of tolerances for resistors and capacitors based on manufacturing tolerances in steps of ±20, ±10, and ±5 per cent., the latter corresponding to the 24th root of 10 (i.e. the "R24" series). This enables the components to be made to any dimension and then graded afterwards, since the limits of tolerance straddle the whole size range (e.g. 1±20 per cent.=1.2/0.8=1.5 which is the next step, and so on).

It is unfortunate that when this conception was introduced, tolerances of ±24, ±12 and ±6 per cent. were not adopted as this would have enabled Preferred Numbers to be used in place of the unusual series now used.

TABLE IV
PREFERRED TOLERANCE VALUES AS USED IN BS.1916
(Unit 0.001 in.)

0.1	0.3	1	3	10	30
		1.2	3.5	12	35
	0.4	1.4	4	14	40
0.15					
		1.6	4.5	16	45
	0.5	1.8	5	18	50
0.2	0.6	2	6	20	60
	0.7	2.2	7	22	
0.25	0.8	2.5	8	25	
	0.9	2.8	9	28	

Arithmetic Progressions

There are many cases where arithmetic progression must be used in place of geometric; this is usually true, however, over a limited size range, and if several arithmetic series are used the result closely approaches a geometric progression. In the normal inch system, used on screw threads, ball bearings, fitted holes and shafts, it is usual to employ steps of 1/16 in. up to say 5/8 in., 1/8th up to 1½ in., ¼ up to 6 in., and ½ in. steps above this. This series of arithmetic progressions is used in B.S.1580, Unified Threads, and for recommended diameters in B.S.1916, Limits and Fits. Fig. 7 shows how closely this follows the R20 Preferred Numbers up to about 4 in., and if the change to ½ in. steps had been made at this point instead of 6 in. the agreement would have been even closer.

In dealing with commodities such as ball bearings, where the ultimate application cannot be anticipated and the various engineering requirements may be legion, the use of fairly closely spaced arithmetic progressions may be fully justified, certainly until Preferred Numbers are very widely used. How often, for example has a machine designer used a 40 mm. bearing to pass over a 1.5 in. (38.1 m.m.) thread and fit on a shaft with a clearly defined enlarged diameter ? Indeed, the existence of two series of bearings, inch and metric, often suits the machine designer very well, if not the bearing makers themselves.

In the practice of the hydraulic firm referred to above, where Preferred Numbers are used for hydraulic cylinder dimensions, an arithmetic progression is used for the piston rod diameter standards. Here, however, there are two factors determining the choice :

(a) the rod size required to deal with the compression or tension load exerted by or on the unit, and

(b) the annular area subjected to pressure to close the unit.

The use of a geometric series is not logical in this case and the firm uses a series in arithmetic steps of 0.2 in., except in the smallest size for which common fractional sizes are used. The range of cylinder bores and rod sizes enables any requirement to be met.

Problems of Basic Standards

The basic standards which engineers must use are often defective in many respects having been found wanting as a result of experience. Even when attempts have been made to achieve perfection (as in the case of the preparation of the Metric System), the inevitable errors of judgment and the development of engineering science over the years result in faults being found.

Dimensional Standards. The greatest standardisation problem of all facing engineers is the choice between the metric and inch systems. Any engineer with experience with the *millimetre* system (as opposed to the Scientific C.G.S. System) will have found it easier to work with than the normal inch system in use in Britain and the U.S.A. However, we have no hope at all of ever seeing it adopted in this country, Board of Trade and Royal Society notwithstanding, unless the United States of America decided to make a change—and this is about as unlikely an event as any engineer could contemplate. The capital investment in the inch is too large in either country to permit the metre to become popular.

What British engineers must do, however, is to modernise and improve the inch system; there is much scope here, particularly by intelligent selection of good practice and rejection of bad.

The average engineer is principally concerned with a single dimensional unit—the inch in this case. He designs, calculates and manufactures in " inches ". What he wants as a basic unit is one which he has to :-

(a) divide up as seldom as possible and,

(b) when he has to multiply it, can do so in a decimal system.

If he were designing the Sydney Harbour Bridge he might find that the inch itself was a suitable unit. All the rivets, bolts and parts could be expressed as simple multiples of an inch and lengths could be given in tens, hundreds or thousands of inches. (At present, he would probably complicate his work by introducing feet and yards).

The inch, however, is not a suitable unit for most types of mechanical engineering, for the very simple reason that it has to be divided too frequently. Examination of any normal engineering drawing will show that the unit itself, or simple multiples of it, is very seldom used; almost invariably a dimension is either a fractional or a decimal one, depending on the particular system in use by the designer.

In former times a sixteenth of an inch was used as a unit in this country and was an admirable unit when working with rule and calipers. With the advent of precision manufacture, interchangeability principles and the use of micrometers, even if parts were *designed* in fractions of an inch they had to be *manufactured* in decimals (thousandths), and since a sixteenth of an inch involves 4 decimal places and a thirty-second of an inch 5 (a 1/64th involves 6!), the machine operator and inspection deal in practice with a very large number of figures on any one drawing. Usually addition and subtraction has to be done in fractions and converted afterwards (witness the engraving of conversion tables on the ordinary 1-inch micrometer).

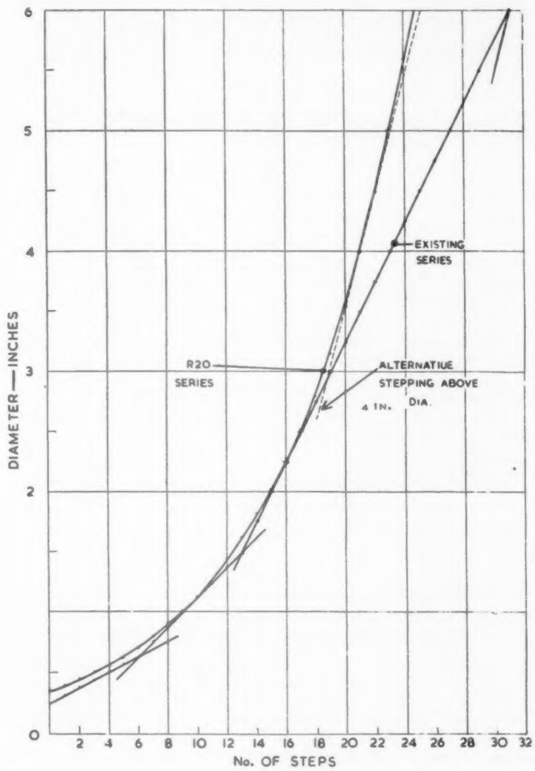


Fig. 7. Comparison of Arithmetic and Geometric Stepping. *(BS.1580 Unified Threads, Special Series, and R20 Preferred Numbers).*

Almost 100 years ago (in 1857) Sir Joseph Whitworth, in making his original screw thread proposals, suggested that the diameters used should be in a decimal series, and recommended this also for limited or gauged holes and shafts.

He said :-

" I have long been convinced that great and rapid progress would be made in many branches of the mechanical arts, if the decimal system of measure could be generally introduced. To state the case broadly, instead of our engineers and machinists thinking in eighths, sixteenths, and thirty-seconds of an inch, it is desirable that they should think and speak in tenths, hundredths, and thousandths. I can assure those who have been accustomed to the fractional system that the change to the more perfect decimal one is easy of attainment, and when once made, it will from its usefulness and convenience amply repay any trouble which may have attended its acquirement."

There are those of us who regret that Whitworth's advice was not taken then, and would urge its adoption now. His original table of preferred sizes could

TABLE V
WHITWORTH'S ORIGINAL TABLE OF PREFERRED DECIMAL INCH SIZES (1857)

			.525		2.125	
		.275	.550	1.125	2.250	
			.575			
	.150	.300	.600		2.375	
			.625	1.250	2.500	5.000
		.325	.650		2.625	5.250
			.675	1.375	2.750	5.500
	.175	.350	.700		2.875	5.750
		.375	.750	1.500	3.000	6.000
.100	.200	.400	.800	1.625	3.250	
		.425	.875	1.750	3.500	
	.225	.450	.900	1.875	3.750	
		.475				
.125	.250	.500	1.000	2.000	4.000	

well be adopted as it stands. (Table V).

To put it into preliminary effect, only a few new standard diameters for drills and reamers, etc. need be introduced, viz.:

0.1	0.3	0.45	0.65	0.9
0.15	0.35	0.55	0.7	
0.2	0.4	0.6	0.8	

Miscellaneous Standards. In several other spheres the battle between the purist and the engineer complicates the work of the latter. Anomalies in temperature scales, for example, are confusing. The American engineer always uses Fahrenheit degrees, most British engineers the Centigrade scale, except for heat calculations where the B.T.U. is common and the pound-calorie frowned on. British engineers as a whole should abandon the °C, or adopt the pound-calorie.

Stresses are still quoted in many circles in this country in tons sq. in., which is really unreasonable; 1000's of lb./sq. in. should be used, even if the name "Kip" for this unit does not become popular. Engineers should forget that there ever were such units as hundred-weights, quarters and stones; they can help themselves by using decimals of a pound in place of ounces.

If the yard can be avoided as a unit, the cubic yard could be replaced by the more universal cubic foot. Similarly the gallon is a poor engineering unit and such units as gallons per minute or per hour are unnecessarily far removed from the engineering flow units of cu. in./sec. or cu. ft./min.

These and many other examples which could be cited, show that the engineer could simplify his own work if he sat down and *selected* those units of measurement which most conveniently meet his needs, and used these at the expense of the many others which are known.

Another example of confusion—not perhaps so technically complicated but not without significance—is in relation to standard paper sizes for drawings, technical data, and indeed correspondence. We have common sizes of $8 \times 6\frac{1}{2}$, 8×10, 8×13, and 10×15 in. The latter is not a good drawing size as it does not fit normal commercial correspondence, which is mainly on foolscap or quarto. American practice in both fields is related to a standard size of $8\frac{1}{2} \times 11$ in., which is a convenient compromise between the two main British sizes, and large enough to be multiplied into convenient drawing sizes. The German standard (8.3×11.7 in.) is close to the American size, and uses the "halvable" basis, where the sides are in the ratio $1 : \sqrt{2}$, so that the ratio remains constant when the sheet is cut. The general adoption in Britain of the latter size would simplify the handling of engineering documents and assist international standardisation.

Conclusion

This Paper has attempted to underline two main points:

(a) that an engineer preparing any new product would be well advised to think out a rational basis on which to establish a range of sizes of the product, with a strong recommendation to make use where possible of Preferred Numbers, and

(b) that engineers can often help themselves by selecting from existing practices a restricted few on which future operations will be based; and that attention to simple elements often pays notable dividends.

"Materials for Gas Turbines"—References (*concluded from page* 453).

(12) "Study of the Properties of a Chromium-nickel-niobium Austenitic Steel." H. W. Kirkby and C. Sykes, I.S.I. Special Report No. 43, pp. 94-106.

(13) "Properties of Materials intended for Gas Turbines." H. W. Kirkby and C. Sykes, I.S.I. Special Report No. 43, pp. 81-94.

(14) "Some Proven Turbine Steels and Related Developments." D. A. Oliver and G. T. Harris, I.S.I. Special Report No. 43, pp. 46-59.

(15) "Effect of Warm-working on an Austenitic Steel." G. T. Harris and W. H. Bailey, I.S.I. Special Report No. 43, pp. 60-67.

(16) W. Crafts and J. L. Lamont, Trans. Am. Inst. Min. & Met. Engnrs, 1950, Vol. 188, p. 561.

(17) "Creep-resisting Ferritic Steels." E. W. Colbeck and J. R. Rait, I.S.I. Special Report No. 43, pp. 107-124,

(18) "Research and Development on High Temperature Materials." H. Sutton and C. A. Bristow, I.S.I. Special Report No. 43, pp. 289-292.

(19) "Machining Austenitic and Ferritic Gas Turbine Steels." K. J. B. Wolfe and P. Spear, I.S.I. Special Report No. 43, pp. 233-242.

(20) "Welding of Heat-resisting Alloys in Sheet Form." H. E. Lardge, I.S.I. Special Report No. 43, 217-224.

(21) "Weld-metal Properties and Welding Characteristics of Two Austenitic Steels for Gas Turbine Motors." E. Bishop and W. H. Bailey, I.S.I. Special Report No. 43, pp. 225-232.

(22) "Sintered Alloys for High-temperature Service." R. W. A. Buswell, W. R. Pitkin and I. Jenkins, I.S.I. Special Report No. 43, pp. 258-268.

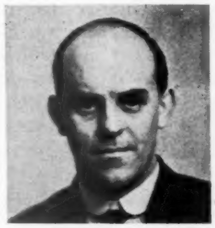
(23) Reeman and Buswell. Inst. of Mechanical Engnrs. May, 1953.

MATERIALS FOR GAS TURBINES

by H. SUTTON, C.B.E., D.Sc., F.R.Ae.S., F.I.M.

Dr. Sutton commenced his career in 1915, as Research Assistant to Professor C. A. Edwards, F.R.S., Regional Controller and Adviser, Ministry of Munitions, Manchester. From 1918 to 1925 Dr. Sutton was engaged on research work at the Royal Aircraft Establishment, and was then appointed Head of the Metallurgy Department, where he remained until in 1943 he joined the Ministry of Supply, where he is now Director, Materials Research and Development (Air).

He is a Fellow of the Institution of Metallurgists and a Fellow of the Royal Aeronautical Society. In 1952, the latter body awarded Dr. Sutton the Simms Gold Medal and the Society's Silver Medal.



Dr. H. Sutton

IT is a privilege to address this meeting on a subject which bristles with interest, not only because of the dependence, from the earliest days of the gas turbine, upon high temperature materials for its effective development, but also because of the great progress which has been made in a comparatively short period of years in relation to other well-known groups of engineering materials.

In view of the great need for improved materials for the aero-gas-turbine in its childhood and adolescence, the relationship of much of the work to that type of gas turbine will probably be appreciated with understanding and tolerance by those particularly interested in gas turbines for other purposes. While no apology is made here for dealing mainly with British work, the important contributions by American metallurgists are well-known and are highly regarded by British workers in this field.

The parts of the gas turbine which have presented the main problems for the metallurgist are :

(1) the rotor blades of the turbine ;

(2) the rotor disc or drum ;

(3) the nozzle guide vanes and stationary blades ;

(4) the combustion chamber and discharge arms ;

but other parts provide much scope for the efficient handling and application of high performance materials, e.g. compressor blades, rotors and casings ; heat exchangers, where these are used ; shafts and bearings. The gas turbine presents a unique opportunity for the designer with his mechanical engineers ; for the specialists on thermodynamics, combustion and fuel technology, aerodynamics, etc. ; for the materials and component manufacturers ; for the metallurgists who evolve and develop the materials to be used ; and many others. Probably no other manufactured product embodies the integrated efforts of so many scientists and technicians.

It may be of interest to refer to the early days of collaboration in the United Kingdom on research and development of alloys for service at high temperatures in gas turbines. During the development of the earliest Whittle engines, experience of high alloy steels of heat-resisting types was made available by steelmakers, notably by the late Dr. Hatfield and his colleagues at Firth-Brown, from 1936 onwards, and this was a substantial contribution to progress of the engines. The work has been admirably summarised by Dr. C. Sykes[1] in the Second Hatfield Memorial Lecture.

Research and development work on nickel-chromium creep-resistant alloys at the Mond Nickel Company, about the time of commencement of the Second World War, and pursued in the light of earlier research work, has been described by Pfeil, Allen and Conway[2] in their paper on nickel-chromium-titanium alloys of the Nimonic 80 type. From November 1939 onwards, following the offer of the services of the Mond Nickel Research and Development resources to H.M. Government, meetings of an informal committee of representatives of the Mond Nickel Company, the National Physical Laboratory, the Royal Aircraft Establishment and the Ministry of Aircraft Production discussed information and suggestions put forward mainly by the Mond Nickel Company. As the work proceeded, it became clear that discussions and collaboration on a broader basis were justified by the importance and scope of the work, and by mutual agreement other groups came into the work under the guidance of a new committee. The Committee on High Temperature Materials set up in July 1941 had as one of its terms of reference : " To consider requirements for these materials and the extent to which research meets them." At the beginning of 1946, the Committee was reconstituted as the Materials Sub-Committee of the Gas Turbine Collaboration Committee and continues as such.

An important task for the 1941 Committee was to set out the requirements and it was agreed that attempts should be made, in the first place, to develop materials that would at least satisfy the following :—

(1) the alloy should not give an extension of more than 0·1% in 300 hours under a stress of 3 tons per sq. inch at 750°C.

(2) the alloy should be sufficiently workable for certain somewhat complicated forgings to be produced in it without excessive difficulty.

(3) the alloy should have the highest possible resistance to oxidation and other corrosive attack at 750°C.

It was, of course, appreciated that other temperatures and stresses would be likely to be concerned, and this proved to be the case. As regards resistance to oxidation many materials, including nickel-chromium alloys, were known to be very resistant for long times at 750°C. and, provided that there was no danger of impingement by burning gases at excessively high temperature, no difficulty in meeting that requirement was anticipated. It was appreciated that the raw materials for production of turbine blades, etc. must not be extravagantly expensive and must be available in fair quantity of sufficiently consistent and reliable quality.

Nickel-Base Alloy Work

The known features of alloys containing, apart from small amounts of impurities, about 80% of nickel and having the rest substantially of chromium made them attractive for research. The Mond Laboratory studied the solubilities of additional elements, the influence of solution treatments and ageing or precipitation treatments at various temperatures. It was quickly discovered that carbon and titanium contents with particular heat-treatments could be used to secure considerably improved mechanical properties, at high temperatures. These studies of the effects of added elements, their solubilities, the manner and rate of precipitation at various temperatures, proved a fruitful field and the work progressed in such a way that the target originally set by the Committee (0·1% creep strain (max.) in 300 hours at 3 tons per sq. inch at 750°C.) was comfortably met and exceeded. The modern form of the 80/20 nickel-chromium alloy with small additions of titanium and aluminium, Nimonic 80A, is expected to give not more than 0·1% creep strain in 300 hours at 12 tons per sq. inch, at 750°C. or in 1,000 hours at 9 tons per sq. inch.

Early Developments

By the middle of 1941 the first alloy of the series, Nimonic 75, had developed to a state at which it was a practical proposition to produce a large disc forging and also sheet material for combustion chambers, also tubes. The important aspects of materials for the intended purposes—stability and durability under conditions of use, ease of fabrication, machinability, suitability for quantity production, etc.—were examined very closely. Much of the early work on these nickel-chromium alloys was described by the late Sir William Griffiths[3] in his Lecture to the Royal Aeronautical Society[3] and by Pfeil, Conway and Allen[4] in a more recent Paper. While the first type of alloy to be developed, Nimonic 75, proved to be of special interest and suitable for sheets for flame tubes, and other applications for which it has since been supplied (Specification DTD. 703) and used in quantity, attention and effort were naturally focussed on the second type of alloy developed, now known as Nimonic 80 or Nimonic 80A. The original criterion of 3 tons per sq. inch, 300 hours, 750°C. for not more than 0·1% specific creep strain was followed by demands for greater resistance to stress at 650°C. Further research and development work at the Mond Laboratory brought out the merits of high temperature solution treatment, the value of suitably combined additions of small amounts of titanium and aluminium, and the importance of selecting the precipitation or second stage heat-treatment to suit the temperature at which the material would be used under stress in service. Production of turbine blades as die forgings in Nimonic 80 was under way in January 1943, following developments on blades machined from bar.

The constitutional studies by Taylor and Floyd[5] followed up recently by Nordheim and Grant[6], provide interesting information on the influence of partial replacement of aluminium in the intermetallic compound Ni_3Al phase by titanium, and of the accompanying increase in lattice parameter of the structure (f.c.c.). The significance of the Ni_3Al phase in Nicomic 80 and 80A and of the partial replacement of aluminium by titanium, also the influence of chromium have been discussed by Hignett[7].

The properties of the Nimonic 80 and 80A continued to progress with increasing experience. Useful data on the high temperature properties of Nimonic 80 are given in Tapsell's and in Frith's papers[8] to the Symposium. The currently expected properties in Nimonic 80A and Nimonic 90 are indicated in Tables 1 and 2. Nimonic 90 is similar to Nimonic 80 and 80A alloys, but contains about 20% of cobalt, by which substantial advantage to strength or working temperature, or both, is achieved. An important quality in alloys for moving blades, stationary blades, flame tubes and other parts is resistance to thermal shock and in this connection the Nimonic alloys have given good service.

Table 1

STRESS FOR SPECIFIC CREEP STRAIN OR FRACTURE T/IN²

	·1%	·2%	·5%	*Fracture*
750°C Nimonic 80A (300 hr.)	12·0	13·5	14·5	15·0
,, ,, ,, (1000 hr.)	9·0	10·5	11·6	11·5
750°C Nimonic 90 (300 hr.)	14·5-15·6	16·0-17·2	17·0-19·0	17·5 19·6
,, ,, ,, (1000 hr.)	12·0-12·4	13·5-14·0	14·5-15·8	15·0-16·3
815°C ,, ,, (300 hr.)	8·0	9·0	10·0	10·5
,, ,, ,, (1000 hr.)	6·0	7·0	7·5	8·0

Other Non-Ferrous Alloys

Cobalt-base alloys, usually containing about 30% of chromium and about 6% of tungsten, have been used for nozzle guide vanes and have been produced

Table 2

Direct Stress Fatigue

750°C Nimonic 80A, 300 hr.	(2000 c.p.m.)		±15 T/in.^{2}
750°C Nimonic 90	,,	,,	±16·7 to 17·0 T/in.^{2}
815°C Nimonic 90	,,	,,	±12·2 T/in.^{2}

as castings, mainly by precision-casting technique in investment moulds. The techniques of production have been described by Gresham and Dunlop$_9$, Gadd$_{10}$ and others. At present, cast moving blades are not in general use in British aero-turbine engines, mainly owing to the difficulty of ensuring that each casting is free from casting defects, but also to the fact that higher fatigue properties have hitherto been obtainable consistently in wrought materials. Although Nimonic 80 was not designed or developed for use in cast forms, remelted alloy has been precision-cast and used effectively in nozzle guide vanes by several British engine firms.

Harris and Child$_{11}$ have described research which led to the development of an alloy for rotor blades, containing about 19% of chromium, 12% of nickel, 45% of cobalt and small additions of other elements. This material has good properties at 700 to 850°C.

Steels for High Temperature Service in Gas Turbines

Austenitic steels are of particular importance for parts of industrial, marine and aero-turbines. An austenitic chromium-nickel-niobium steel has been closely studied by Kirkby and Sykes$_{12}$, the results suggesting that heat-treatment is a factor of greater influence than grain size *per se* in relation to creep performance at high temperatures. The same authors give very full information about four austenitic alloys which are finding application in blading for long-life gas turbines$_{13}$. They give the results of creep tests up to 10,000 hours' duration, which show that extrapolation of data from 300 to 1,000 hour creep tests to indicate performance after longer periods may be very misleading.

Although ferritic materials for gas-turbine discs have been under investigation in Great Britain since 1944, it was not until fairly recent years that they came to be extensively used. Of the austenitic materials which were used, the most popular was G18B, development of which, together with warm-working technique, has been described by Oliver, Harris and Bailey$_{14, 15}$. It is now usual to use ferritic steels for discs of aero-turbines for several reasons, the principal ones being the high proof stress and general strength properties attainable, economy of strategic metals, ease of manufacture, and lower cost than austenitic steels and alloys. The higher thermal conductivity and lower thermal expansion are also, in general, of advantage. The ferritic disc steels used are of several types having alloy contents from less than 1% to about 13%. Popular types are carbon-molybdenum, molybdenum-vanadium, chrome-molybdenum and high chromium. These steels are hardened by cooling in air or oil from a fairly high temperature, e.g. 1100°C., and tempered at a temperature higher than those to be encountered in service. The high chromium type has the advantages of improved resistance to scaling in service and to corrosion during storage, compared with low alloy steels.

It had been known for a long time that the hot strength of ferrite is increased in moderate degree by manganese and more powerfully by molybdenum. Research by Crafts and Lamont on the carbides precipitated in alloy steels tempered at 650°C.$_{16}$ for long periods, followed up by studies of creep properties of alloy steels in relation to their constitution by Colbeck and Rait$_{17}$ has shown the powerful effect of vanadium carbide (VC) in ferritic steels. The heat-treated steels of suitable compositions have a bainitic structure containing VC in a finely divided condition and the particles appear to be very reluctant to coalesce at temperatures up to 650°C. Other carbides, e.g. chromium carbide Cr_7C_3 tend to coalesce at such temperatures and creep resistance diminishes.

A great number of stator blades has been produced as precision castings in H.R. Crown Max and similar high alloy steels. Large castings, e.g. diffuser casings, nozzle guide rings, in similar heat- and corrosion-resisting steels have been made in large numbers as centrifugal castings. Shell moulding has been used for castings of various types and use of this technique appears likely to increase. Ring-shaped pieces are also made by rolling from pierced billets or by forming from extruded or rolled sections and completing the ring by a butt-weld.

Heat exchangers of industrial gas turbines demand reasonably cheap but durable material for the tubes, particularly where reheat is used, temperature and corrosion being the main factors ; vanadium residues from the products of combustion of some oils aggravate the damage seriously.

Other Materials

In aero-turbines wrought light aluminium alloys have been used extensively for rotors, discs and blading of compressors, RR.57 and RR.58 in particular. Aluminium alloy castings are used in miscellaneous other parts.

Magnesium-rich alloys are used for castings of moderate to large size for compressor casings and other parts. The modern types of alloy containing zirconium and rare-earth elements have proved of particular advantage, because of the remarkable soundness achievable and of the improved creep resistance of these alloys at raised temperatures relatively to earlier alloys.

General Features of Materials for Gas Turbines

Although the requirements are particularly exacting and there is so much to be gained by improved performance, materials for gas turbines must be reasonably available in respect of both quality and cost$_{18}$. The expenditure involved in developing an engine material and taking it through all the stages which lead, in some cases, to eventual use in production engines is very high and there are quite enough

difficulties outside the problems of supply of raw materials.

It is of first importance that materials for gas turbines shall be good engineering materials in the generally accepted sense of the term, as well as having the desired properties at particular temperatures called for by the special conditions of use. Not all the properties can be controlled to give the desired degree of amenability to the usual metal fabrication and handling techniques.

The materials which are subject to high temperatures must possess a substantial degree of stability at those temperatures and preferably some margin for accidental exposure to even more severe conditions without catastrophe. They must be reasonably stable in respect of resistance to oxidation ; in retention of strength, creep, and fatigue properties ; in dimensional characteristics ; and in resistance to cracking under repeated thermal stressing. The alloys which have found extensive use as moving blades are all characterised by development of their useful properties by a high temperature heat treatment followed by a treatment or treatments at lower temperature, the first treatment causing some constituents to go into solution, and the later treatment or treatments causing partial " precipitation " of one or more of these special constituents from solution. It is important that there should be little further change under operating conditions and a feature to be kept under observation is the tendency for stress to hasten " precipitation " in some cases. In the early days of gas turbines, there was some optimism about apparent creep resistance or absence of creep during creep tests of particular alloys at high temperature under stress. This was found to be due to a tendency of particular alloys to shrink on reheating to lower temperatures after being heat-treated at an appreciably higher one, whether stressed or not. Low thermal expansion enables use of small clearances and reduces risk of distortion under non-uniform heating. The lower the specific gravity of a blade material, the better, since the main stress is centrifugal.

Present designs of gas turbine blade have a complicated section with taper, twist and other features which present problems for the production engineer. It is usual to make rotor blades from forgings, but many have been machined from bar, especially those of the smaller sizes. Forgeability is not easily attained in materials designed for high strength at high temperatures and it is to be expected that forging temperatures will be substantially higher than operating temperatures in service. It has been usual to forge blades oversize and to finish them by machining ; much effort has been expended in development of techniques for precision forging so as to leave the aerofoil part of the blade requiring only a polish, but the problems involved in securing surfaces free from contamination and manufacturing defects, and the cost and numbers of forging dies, have been major difficulties to full-scale operation.

Castings in heat-resistant alloys for rotor blades have generally proved to be less reliable in service than the wrought materials, but if operating temperatures continue to rise as they have in recent years, a position may be reached at which the alloys that will be required may have to be produced as castings or as sintered products. At present operating temperatures, higher fatigue strengths are achieved in the wrought alloys than in castings, in materials of which there is experience in both forms. Vacuum melting and casting of high temperature alloys is showing some promise of yielding castings of improved quality and, at this stage, it would not be wise to assume that castings in suitable alloy and of high quality will not come into favour for rotor blades.

The higher operating temperature in the hot zones of modern aero-turbines have made thermal-shock resistance a matter of greater significance and difficulty, and have probably lessened the prospect of utilisation in high performance engines of many materials which have been considered for use at high temperatures, and which have many attractive features but not very good resistance to thermal shock, e.g. carbide alloys containing some 30% by weight of metallic bonding.

Machinability

Machinability is obviously a very valuable quality of any material from which parts of gas turbines are to be made. The alloys used vary greatly in machinability. Wolfe and Spear[19] have surveyed the problems involved, and experience gained in workshop operation of the various techniques. It is possible, in heavy cutting operations, to produce strains in the material near the surface which have an injurious effect on the finished component, and care must be taken that cutting in finishing stages shall be clean and not such as to disturb material near the surface. From forged blades, material which has been affected by oxidation or contaminated in any way must be removed completely during the machining. Vapour blasting and hand polishing are commonly used for finishing blades and other components.

Most of the wrought high temperature materials are amenable to welding and a considerable amount of the sheet metal work in alloys and heat resistant steels is fabricated into components with the use of welding. Fusion and resistance welding techniques are used. Oxy-acetylene, carbon-arc, argon-arc, metal-arc, and metal-inert arc processes and the various resistance welding techniques are used as required. The accuracy to which the parts have to be made as regards form and dimensions is higher than normal and calls for high manipulative skill. Recent papers by Lardge, Bishop and Bailey deal with the technical features[20, 21]. Attachment of blades to discs by welding has been investigated both in U.S.A. and in the U.K., but in aero-turbines there has been difficulty in avoiding appreciable stress concentrations which lead to cracking. The mechanical damping afforded by conventional blade fixings is thought by many to afford worthwhile advantages.

Future Trends

If operation at higher temperatures is required in future years, it seems clear that either yet further improvements in alloys for the hotter regions must

be achieved, or that means of cooling the components will be necessary.

With any type of alloy or steel which has been under development for some years, there tends to develop a position from which further gain of properties at high temperature is achievable only by a vast expenditure of effort, or by sacrifice of some quality of the material, e.g. resistance to impacts. The improvements gained by accumulation of experience in producing the metals themselves, in making, melting, casting and manufacturing alloys of known types, have been very gratifying to all concerned. Further advances of known types are likely to be achieved. It seems possible, however, that the use of elements which are not so attractive from the points of view of world strategy, availability, or economy may come more prominently into the field. Molybdenum-rich alloys appear likely to merit consideration for use at temperatures upwards of 1,000°C. if a satisfactory method of protecting the surface from oxidation etc. can be devised, an important requirement being that the protective effect shall persist even though the component be subjected to high temperature, stress and strain.

Bonded carbides, borides, silicides, etc., that have been investigated as far as the stage of trials in engines appear to have been rather brittle and liable to suffer damage at corners, sharp edges, etc., during ordinary workshop handling, and some have shown rather poor resistance to thermal shock. It will be safe to assume that the best has not yet been achieved in this field.

Sintering techniques for preparation of high temperature metals in useful forms from powder have long been used for tungsten, molybdenum and others. There has been much experimentation and development in connection with iron alloys and other alloys for use at high temperatures. Sintered and infiltrated iron-copper alloys developed by the American Electro Metal Corporation, Yonkers, have been manufactured into compressor blades on a considerable scale. Sintered carbonless Vitallium (64 Co : 30 Cr : 6 W) has been prepared and studied by Buswell, Pitkins and Jenkins[22], who obtained in this way a high quality product. The general mechanical properties were good, but creep resistance at 600°C or higher was not so good as that of the carbon-bearing cast alloy.

The quest of hollow blades for application of cooling and also for light-weight, stiff stator blades has stimulated development of these blades by powder-metallurgy, by casting techniques, in solid wrought forms, and by fabrication from sheet, strip, tubes, etc. Reeman and Buswell[23] have described sintered blades having cooling passages (0·030 ins. or 0·040 ins.) suitably disposed within the blades and passing from root to tip.

Titanium-rich alloys appear likely to prove of advantage in compressors for aero-turbines in regions in which temperatures up to 400°C are concerned and possibly for service at higher temperatures in future years. Uses envisaged, and under development, are blading and discs of compressors. Sheet alloys are likely to find application in other parts of engines and ancillary equipment that are not subjected to very high temperatures in service.

There is great interest in porous bodies prepared by sintering and other techniques for transpiration cooling and it is to be expected that, with increasing experience, these bodies will find useful application in turbine engines. There are applications in view in which the cooling fluid not only diminishes attack by harmful gases as a result of the cooling effect, but also tends to prevent accumulation and adherence of harmful deposits.

Cladding techniques by which a layer of more resistant material is applied to one or both surfaces of sheets of less expensive material have been developed and clad steels and copper have been produced. These materials are receiving a good deal of attention.

In the time and space available it has been possible to refer only briefly to the various aspects of the subject and to particular contributions. Many that could appropriately have been mentioned have not been and in many respects the treatment here has been quite inadequate. The Author wishes to thank those in industry who have worked, assisted and collaborated in this field, to whom much of the progress and information available is due.

The Author thanks the Chief Scientist, Ministry of Supply, for permission to present this Paper. It should be understood that views and impressions indicated are those of the Author.

REFERENCES

(1) "Steels for Use at Elevated Temperatures." C. Sykes, Second Hatfield Memorial Lecture, J. Iron & Steel Inst. July 1947.

(2) "Nickel-chromium-titanium Alloys of the Nimonic 80 type." L. B. Pfeil, N. P. Allen and C. G. Conway, Special Report No. 43, Iron & Steel Inst., 1952, pp. 37-45

(3) "High Temperature Alloys." W. T. Griffiths, J. Roy. Aero. Soc., 1947.

(4) See (2) above.

(5) "The Constitution of the Nickel-rich alloys of the Ni-Cr-Ti System." Taylor and Floyd, J. Inst. Metals, July 1952, Vol. 80, pp. 577-587 ; Sept. 1952, Vol. 81, pp. 23-32 ; May 1953, Vol. 81, pp. 451-464.

(6) "Ageing Characteristics of Nickel-chromium Alloys Hardened with Titanium and Aluminium." Nordheim and Grant, J. Inst. of Metals, Vol. 6, No. 2, Sect. 2, Jan. 1954, pp. 211-218.

(7) "High Temperature Alloys in British Jet Engines." H. W. G. Hignett, Am. Soc. Metals, Detroit Chapter Lecture, 12th Nov., 1951.

(8) "Fatigue at High Temperatures." H. J. Tapsell, I.S.I. Special Report No. 43, pp. 169-174.
"Fatigue Tests at Elevated Temperatures." P. H. Frith, I.S.I. Special Report No. 43, pp. 175-181.

(9) "Investment Casting of Nozzle Guide Vanes." H. E. Gresham and A. Dunlop, I.S.I. Special Report No. 43, pp. 209-212.

(10) "Precision Casting of Turbine Blades." E. R. Gadd, I.S.I. Special Report No. 43, pp. 212-216.

(11) "Development of a High Temperature Alloy for Gas Turbine Rotor Blades." G. T. Harris and H. C. Child, I.S.I. Special Report No. 43, pp. 67-80.

(*concluded on page* 448)

PRODUCTION CONFERENCE

SESSION VIII

INTRODUCTION OF WORK STUDY INTO SMALLER FIRMS

by H. G. WOOD,

M.A., B.Sc., M.I.W.M.

Mr. H. G. Wood

Mr. Wood holds M.A. and B.Sc. Degrees from the University of Glasgow, and has a broad experience of industry as works manager, as consultant, and latterly as lecturer in Work Study at the Royal Technical College, Glasgow.

He was trained in management, including Work Study, by Thomas Hedley & Company, Limited, and afterwards held posts as Factory Manager and Works Manager with Marshall's Food Products, Limited and Tintex Dyes, Limited, and as Managing Director of Marshall's Food Products (Scotland) Limited. He has also spent some time with Stevenson, Jordan & Harrison, Limited, as a consultant specialising in Work Study.

Mr. Wood joined the British Productivity Council from the Royal Technical College, Glasgow.

MAY I first say a word about the small firm, in order to dispel the idea that lack of size in any way implies lack of importance. There are two reasons why the small firms are important, the first being that they account for over 80 per cent. of Britain's industrial production and the second, that there is growing evidence that the small firm can be in many ways at least as efficient as the large combine, mainly because of the close contact possible between manager and man.

The question is whether the small firm can have the best of both worlds—the advantages of a compact, close-knit organisation and the benefits of large-scale operation. In many matters such as the use of large mass production machinery it is obvious that the small firm is at a disadvantage, but in the application of managerial techniques such as Work Study there is no basic reason why these should be the prerogative of the large firm, although they have been developed mainly by the larger concerns. Indeed, progressive firms, both large and small, have been using Work Study effectively for a long time, and the purpose of this Paper is to examine simply how it can be done to the best advantage in the small firm.

What is Work Study ?

Work Study is the study of work. Study implies a close examination. Work for our present purposes we shall define as industrial work, although the technique can be applied equally well to all work—in the home, in the office, on the land—as well as in the factories.

Work Study has two main sub-divisions—Method Study, which is concerned with the critical examination of existing (or proposed) methods with a view to improvement, and Work Measurement, which seeks to determine the proper time to allow for each task.

In essence the job of Method Study is to get rid of unnecessary work—particularly manual work, and that of Work Measurement to supply data to assist in achieving better management and better utilisation of all productive resources.

Method Study may be called scientific in so far as it follows the pattern of the scientist who analyses observed facts, classifies the results of the analysis, selects what is useful for his purpose, and then puts this knowledge to effective use. Method Study, in seeking to develop improved methods, is concerned with the detailed analysis of the existing or proposed process into its constituent parts, and classification of

those activities as ' useful ' or ' non-useful ' from a productivity point of view, the selection of the useful (with the corresponding rejection of the useless) and the building up therefrom of the new, more effective method of working.

Work Measurement, in attempting to determine the proper time to be allowed for an operation, deals with the determination of the effectiveness of the *human* content of the work involved in any activity.

It will be apparent that the technique of Work Measurement is not a precise and scientific technique, and that although an accurate measurement of time can be made (i.e. with a stop-watch), there must remain an element of subjective judgment in the assessment of the other variable, the tempo and effectiveness of the work being measured.

Experience has shown that human judgment can be trained to a satisfactory degree in this field, but it will be seen that the training cannot come from a book. The fundamental requirement in Work Measurement is a deep understanding of actual industrial work. This aspect of Work Measurement is important, as will be seen later.

Properly used, Work Study is one of the quickest ways of increasing productivity from existing resources, and it has also an important contribution to make in the fields of development and design. It is, however, no panacea—and certainly no substitute for good management. It is a sharp and useful tool of management, but like other sharp tools it must be placed in competent hands or someone is liable to get hurt.

Starting Work Study in a Factory — A Prerequisite

Work study, in an informal sense, has been going on as long as work, but formal Work Study, as an intensive and specialised technique, is relatively new and its introduction into any factory, large or small, brings new problems, some of which apply to all specialisation of function and some of which are peculiar to this particular subject.

The basic problem is that with the best will in the world, Work Study implies changing the ways of management and workers alike, so that the impact on the human side of the organisation is liable to be severe.

A prerequisite in all cases, therefore, is a thorough mastering of the principles of the subject and its ramifications, by the head of the concern, so that he can anticipate the human problems involved and take the necessary steps—in framing policy, in re-organisation, and above all in giving his own whole-hearted and enthusiastic support—to make the introduction of Work Study a success.

He can follow the example of an enlightened director of a foundry who actually ' came back to school ' for three weeks to learn about it, or he can attend an appreciation course and read up the subject afterwards so that he knows enough to talk to his people about it and to supervise those concerned with applying it. Work Study will never achieve the best results if it is clear to all concerned that the ' old man ' is pretty hazy about it himself!

There are not nearly enough of these short appreciation courses for top management and here I would like to pay tribute to I.C.I., who are now running ' open days ' on Work Study for the benefit of such people. That is the sort of thing we need both in the particular sphere of Work Study and in our approach to the problem of increasing productivity generally—the free and widespread dissemination of knowledge of these techniques.

In the BPC we are trying, with the help of the Local Productivity Committees, to do the same thing, through the Circuit Schemes, by pamphlets and films, and in the case of Work Study, by our newly-formed Work Study Unit, which will move around the country as required to give appreciation knowledge of the technique and its value in increasing productivity, although it might be wise for me to mention here that that is all that the Unit can hope to do—to stimulate interest, understanding and acceptance of Work Study as a good thing for everybody. I must deprecate any suggestion that we shall be offering a get-rich-quick solution to our problems. As will be seen in this Paper, the actual implementation of Work Study requires great care and good management.

The important thing here is worth repeating—the organisation is only as big as its head. The head executive *must* be completely convinced of the value of Work Study, be prepared to face up to the implications of it, and to give it his whole-hearted support.

Four Steps in Application

Following on this preliminary stage, there are four basic steps in the implementation of Work Study :—

1. Getting Work Study accepted by management at all levels.
2. Getting the cooperation of the employees and of their Trades Unions.
3. The selection and training of Work Study personnel.
4. Doing the job.

1. Getting Work Study Accepted

Because Work Study involves change and alterations in manning, and because there is often a lack of understanding of the subject, there may be initial resistance to it. These difficulties can only be overcome by spreading knowledge and appreciation of needs and methods throughout the organisation as a whole—and particularly among key representatives of workers and management such as shop-stewards and foremen. This demands the full and frank discussion of the subject and its implications.

It is encouraging to see so much being done by the Trades Unions in this connection—in the courses arranged within industry and at the TUC Training Centre at Clapham. Also, the week-end conferences arranged by the various management bodies and, last but by no means least, the work of the technical colleges in this direction. The big advantage of the latter is that representatives of management and Trades Unions sit round the same table in joint

consultation on the subject, which brings me to my next point.

2. Getting the Co-operation of the Trades Unions

Thanks to the efforts mentioned above this job is becoming daily less difficult, but it should not be neglected because of this. The best results can only come if there is the fullest consultation between management and Unions both before and during the introduction of Work Study. Free and open discussion of the subject at all levels at all times, and in particular *before* the start of Work Study, is the golden rule here, with sound industrial relations as the essential background.

3. The Selection and Training of Work Study Personnel

The problem of selection is an interesting one, for Method Study calls for an enquiring mind and an attitude of constructive cynicism—' taking nothing for granted '—while Work Measurement is more static—being concerned with ' what is ' rather than ' what ought to be,' and the essential is precision, thoroughness, a deep understanding of the worker's point of view, and the strength of character to umpire. A somewhat unusual combination of qualities, but one which should be sought. This may take time and money, but in the end it will pay to choose the right people. The old tendency of using Work Study as a convalescent home for aged and infirm foremen is to be deprecated. To be a good Work Study man a man must be capable of being a top-ranking foreman. By converse, of course, Work Study is an excellent training ground for the up-and-coming foreman.

The Special Problem of the Small Firm

Until now the problems to be dealt with and the steps to be taken have been common to firms of all sizes, but in the next stage—the training of personnel and the expert supervision of the Work Study—the special problem of the small organisation appears.

With the large concern, the training of Work Study personnel and the actual ' doing ' of the job present no special difficulty. The firm either employs consultants or establishes a Work Study Department of its own.

The small firm, on the other hand, usually cannot afford such measures, profitable as they may be and, indeed, in many cases there is no need for such a specialised approach, but rather for the supervised training of existing personnel in the new technique.

It is to the credit of the consultants that they are trying to find a way round this problem of how to lower their costs to the small man without lowering the quality of their service. Some of them are trying to work the 'cheaper by the dozen ' approach of handling several small assignments simultaneously, the consultant's time being shared. A praiseworthy attempt, although with two drawbacks, one being that the consultant's life is already highly nomadic, and the other being the inherent inefficiency of ' half-days,' especially in a subject like Work Study where all sorts of problems are liable to crop up calling for constant and close supervision and care.

In considering alternative methods of training Work Study men, may I remind you of my earlier statement about the difference between the two branches of the subject—Method Study and Work Measurement, namely, that Work Measurement involves the use of subjective judgement, the training of which is all-important and can only be done on the shop floor over a long period of time.

Furthermore, the greatest risk run by faulty Method Study is the continuance of second-best practices and lay-outs, whereas the repercussions of slip-shod Work Measurement, especially if used for incentive schemes, can be serious and far-reaching.

Training in Work Measurement, therefore, presents a much more difficult problem than training in Method Study, but what is not realised by many managements today is that the simple but whole-hearted application of Method Study, from the top to the bottom, will generally pay bigger dividends for all concerned than the equivalent expenditure on Work Measurement.

Co-operative Training

Whether we are thinking of the easier technique of Method Study or the more difficult one of Work Measurement, it will be apparent that the crux of the matter as far as the small firm is concerned is some form of co-operative action, either in employing consultants as mentioned above or in the establishment of centralised training schools—within the industries themselves or through the medium of existing establishments such as technical colleges.

Several new and encouraging developments in this direction are now taking place through employers' organisations such as the Engineering and Allied Employers West of England Association, and in the cotton, woollen and jute industries, where suitable men are given full appreciation and theoretic instruction in the subject followed up by practical training in the workshops of member organisations.

To deal with the needs of the individual firm which is not a member of such a federation, there has recently been established the Work Study School attached to the College of Aeronautics, at Cranfield, and other praiseworthy attempts to help industry in this problem are being made by the universities and technical colleges throughout the country, with one of which I myself have been recently concerned, namely the provision at the Royal Technical College, Glasgow, of a follow-up training service from classroom to work-room.

The service provided at these centres is probably adequate for training in Method Study, but a more extensive ' on-the-job ' period is necessary for Work Measurement—to achieve the high standard of judgment required.

Nevertheless, such technical schools do seem to provide a potentially excellent training ground, and of course, they are the logical place to deal with the other problem, referred to earlier, of disseminating knowledge of the subject, which is essentially an educational function.

The provisional conclusion that must be drawn at this stage is that there already exist reasonably good facilities for training in Method Study, but that more needs to be done, by co-operative effort, to

provide adequate training in Work Measurement, which should be coupled to some form of 'poor man's consultancy' to meet the needs of the small firm.

4. Doing the Job

Whether the job is considered from the staffing angle, with the difficulties just described, or from an objective point of view, it is clear that preliminary Method Study should precede Work Measurement. There is no point in spending a lot of time measuring some process or operation that can be dispensed with or radically improved by Method Study. Remember, too, that the best place to do Method Study is at the design stage—as Mr. R. M. Currie, of ICI, says : "It is easier to use an indiarubber than a concrete-breaker."

So from design to production methods and organisation, then to Method Study of individual jobs, and, finally, the setting of standards by Work Measurement. Where one should start and how much one should do I prefer to leave to the discussion stage, but a warning should be given against the use of slip-shod time study simply to get an incentive scheme going. Attractive as this may be to give workers more money and management more production, it does not pay in the long run and, as I said earlier, even in the short term it is probably true that a given expenditure can bring bigger benefit to all if devoted to Method Study.

Incentive schemes are excellent things, both for rewarding diligent workers and for keeping management up to the mark by forcing them to organise the flow of work properly, but they should be a second-line attack and should be based on sound Work Measurement or, attractive as they may seem initially, they can rapidly run into trouble and become a thorn in the flesh of the organisation.

Finally, do not expect miracles overnight. Frequently there are spectacular early results from Work Study, but the essence of Study is thoroughness and the work we are studying is human work—a complex and difficult subject.

Conclusion

I have tried, in this short talk, to outline some of the problems which arise in introducing Work Study into the smaller factory and, I hope, offered one or two suggestions as to their solution. I have felt it necessary to talk about Work Study itself but have done scant justice to such a big subject in so short a time. Inevitably there are many vital points that I have omitted, yet on the other hand I must have bored the knowledgeable among you. I hope the discussion period will help to correct these sins of omission and commission.

May I finish by quoting to you Objective 12 of the BPC which sums up the whole idea :

> "It is not sufficient to understand and accept the fact that 'as we produce, so can we live.' It is for everyone, whatever his position or job may be, to increase the effectiveness of his own work by every possible means. Only if this is done can our present economic difficulties be overcome, so that all may receive the benefit of improved living standards and of true security."

REPORT OF THE PRODUCTION CONFERENCE, OLYMPIA, 1954

A full report of the Proceedings of the Production Conference, including the Papers and the ensuing discussions, will be published towards the end of September, price £1. 1. 0. per copy, post free.

An order form is included in the Supplement to this Journal, and those interested in obtaining a copy of the report are asked to complete the form and send it, togther with a remittance, to the Secretary of the Institution, as soon as possible, in order that printing requirements may be estimated.

STANDARDS IN THE ELECTRICAL EXPORTING INDUSTRIES

by D. MAXWELL BUIST,

M.I.E.E., M.I.Ex.

Mr. D. M. Buist

Educated at Edinburgh University, Mr. Buist was trained in the Engineering Departments of the Scottish Iron and Coal Company. He has been subsequently Distribution Engineer of the Fife Electrical Power Company; commissioned instructor in the Royal Flying Corps, during the First World War; Chief Technical Assistant to Edinburgh Corporation; Deputy City Engineer, Hull Corporation; Chief Electrical Engineer of I.C.I. Ltd.; and Manager of the Central Electricity Board for N.E. England. He is now Export Director of B.E.A.M.A.

Mr. Buist is a prominent member of the Institution of Electrical Engineers. He was awarded the I.E.E. Paris Premium in 1930; was Chairman of the I.E.E. North-East Section in 1937; a Member of the I.E.E. Council from 1936/1939; and has been an I.E.E. Official Examiner for five years.

He has taken part in a number of Government Trade Missions, including the China Trade Mission, in 1946; the Canada Engineering Mission in 1948; the Middle East Missions, 1953; and was leader of the Canada Electrical Standards Mission in 1949. Mr. Buist is the author of numerous papers on electrical and industrial subjects.

IN these days when Britain's paramount need is to increase her export trade, the electrical industry can point with some pride to its achievements. In comparison with industry generally, the increase in exports in recent years as compared with prewar has been spectacular. In 1938, the British electrical industry led the whole world in electrical exports with a figure of about £M23. By 1952 and 1953 this had been increased about ten times, and the electrical manufacturing industry became the second largest exporting industry in the United Kingdom. There is no doubt that British Standards contributed materially to this achievement, and that still more standardisation will increase the effectiveness of the industry as an earner of overseas currency. There are, of course, certain features of electrical equipment which specially call for standards—both for the home and export trade. I have in mind such questions as safety and the standardisation of voltages. The fundamental contribution of standards to increased efficiency of production, however, both as regards the basic machinery, lay-out, etc., and in the limitation of designs, types, sizes, etc., is common to all industries and for this reason alone, the experience in the electrical industry of the effects of standards in relation to export must be of interest to other exporting industries.

This "fundamental contribution" I have mentioned is generally accepted in the major industries, but it is sometimes argued that the requirements of overseas customers necessitate a degree of variety which must in turn necessitate a sacrifice of the economic benefits which could otherwise be secured by standardisation. I, too, am mindful that the U.K. must be ready to provide products tailor-made to the individual requirements of its overseas customers wherever this is wanted. What I have in mind as regards the standardisation of production is the elimination of unnecessary variety and the greater use of standardised elements and components however special the ultimate assembly may be, for we live in a world of keenly and increasingly competitive prices. A further advantage of standardisation of this kind results from the export of products for which spare parts and replacements can be obtained with ease and certainty. It is undoubtedly short-sighted for a section of British industry, as it is for a particular manufacturer, not to ensure that basic components

are interchangeable. The adoption of British Standards for such components, agreed after discussion between manufacturers and users, in the long run benefits not only the users, at home and overseas, but the manufacturers also.

As I have indicated, the electrical industry has accepted the principle that good standards techniques have been and remain essential to its success in the export trade. The use of standards in the industry is demonstrated by the very large number—about 400—of British Standards for electrical goods which have been drawn up, constituting some 20% of all British Standards. The " standard " features covered vary widely—dimensions, performance, e.g. of meters and of motors, quality of materials, use of terms, methods of test. These Standards represent the work of many years ; from the earliest days the industry supported the movement towards standards—both at home and in the international sphere—and as early as 1911 the B.E.A.M.A. itself set up its own Standardisation Committee. A series of specifications covering a wide variety of products was drawn up by this Committee, but these were later replaced by corresponding specifications issued by the British Engineering Standards Association (later the B.S.I.)

An Important Selling Point

The existence of these standards and the fact that goods for export are extensively made in conformity with them is important to my industry's export trade in a number of ways. The effect of increased productivity and the related ability to quote keenly competitive prices is, of course, fundamental, but of great importance also is the reputation of British Standards for electrical goods, the assurance which is given to the purchaser by the knowledge that the goods he is buying are in accordance with a British Standard. British Standards for electrical goods are kept at a high level. The consequence is that, over the years, they have achieved a reputation which constitutes an important selling point for British electrical manufacturers. We have found over and over again that this is a valuable supplement to the words, " MADE in BRITAIN." In the electrical industry at least, British Standards have an established reputation. That is not to say, however, that they are as widely known in all our export markets as they ought to be, e.g. in the Middle East and in South America, and more thought needs to be given by the B.S.I. and by industry to methods of spreading information about our standards and encouraging their use in such areas. This is a matter of much importance to which we must give more attention than we have so far done. As a member of the recent U.K. Trade Mission to the Middle East I have had this brought home to me very forcibly in relation to the markets of that region.

British Standards Overseas

Given that British Standards are known and understood, an overseas purchaser who is supplied with goods " made to British Standard XYZ " knows what he is getting and in countries such as Australia and New Zealand where the national standards are basically similar to the British Standards, compliance with the British Standard usually ensures that the product is acceptable in those countries. The existence of British Standards which, through experience, have established a wide reputation in overseas countries, often means, too, that local statutory requirements will conform with British specifications and practice. This may prevent a formidable barrier to British exports being set up and this is especially important in countries which are only now developing their own standards. There remain, of course, the other familiar trade barriers, but the existence of acceptable standards is a fundamental starting point for the export of all electrical machinery. Similarly, in negotiation on an international standard or recommendation for any product, a well-tried British Standard, known in many overseas countries, may result in the adoption of an internationally agreed specification which will substantially reflect British practice and confirm it over a wide area of export trade.

Negotiations for international standards agreements in the electrical field are mainly carried out through the International Electrotechnical Commission (I.E.C.). There is also, so far as safety regulations in certain European countries are concerned, the International Commission on Rules for the Approval of Electrical Equipment (C.E.E.) in which the United Kingdom also has a place.

The work of the I.E.C. started just 50 years ago—the Commission's Jubilee will be celebrated in September of this year at meetings to be held in Philadelphia. The electrical industries of the world were the leaders in the movement to secure international agreement on fundamental standards and the British industry has played a leading part in the work. The record of international recommendations agreed and published over the 50 years of the life of the I.E.C. is impressive, and much was achieved before other industries had begun to think in terms of such international agreement. The subjects covered by these recommendations range from circuit breakers, mercury arc rectifiers and electric traction motors, to name a few items of equipment, to the less tangible subjects of vocabulary and graphical and letter symbols to be used in the electrotechnical field. Work has in recent years extended into the field of telecommunications and radio interference, and, with the introduction of new insulation materials, a revision of the well-known classification of such materials is being undertaken.

The volume of work done in the I.E.C. is still steadily growing and simultaneous meetings of a wide range of committees are an annual event. Other meetings are held at intermediate times and last year, for instance, there was a total of over 50 meetings. The Jubilee celebration in Philadelphia will coincide with the meetings of about 50 Technical Committees and Sub-Committees and a very strong delegation from British industry will be attending.

Primary Aims of I.E.C.

There are two matters of special importance which I have always had clear in mind about this

I.E.C. work. First, we are not trying to secure an absolute uniformity of product throughout the world ; the objective, which is wide enough in all conscience, is to secure agreement on the basic matters so that true competition in various features of originality and quality, as well as of price, can operate and be seen more clearly without fundamental hindrances getting in the way of the international exchanges of goods. Second, that we must regard the British Standard as paramount and that we must not be willing to see that Standard lowered solely in order to secure an international agreement. Subject to these generally overriding considerations, the objective of British participation in these international meetings is to assist in arriving at recommendations which will form the basis of national standards in all the participating countries. In general, it is the case that we shall gain by keeping in line on the basic internationally agreed requirements of electrical equipment provided there is reasonable flexibility on subsidiary features.

It is perhaps instructive, by taking a specific example, to review the sort of considerations which can arise. The British Standards for rotating electrical machinery have for many years recognised a rating permitting overloads as an alternative to the rating based on the continuous maximum load. The I.E.C. recommendations regarding motors and generators, on the other hand, recognise only the continuous maximum rating. This has meant that a British-made machine with a given nominal rating to the British Standard, has been larger than a machine of similar nominal rating made to the I.E.C. specification. In the past, the inherent reliability and overload capacity of British-made machines has enabled them to compete with foreign-made machines in spite of the extra cost of production of machines made to our specifications, but in the fight for exports to-day these features are apt to be overlooked and price can become the main consideration. There are, therefore, strong grounds in favour of bringing the British Standard ratings into line with the I.E.C. ratings and of abolishing the rating based on an inherent overload capacity. On the other hand, such a radical change in practice in this country would undoubtedly cause confusion in the initial stages, and for this reason a compromise is at present under consideration in connection with the revision of the British Standards for electric motors and generators. It is proposed to retain the load-plus-overload basis of rating for machines up to a certain size (50 H.P.) and to rate all larger machines on the basis of the continuous maximum loading.

British Participation

British participation in the work of the C.E.E. is more recent than in the case of the I.E.C. This body is primarily one concerning the requirements of Continental countries. Even though the sphere is limited, we must keep in touch with its activities. Its work is based on systems of compulsory approval of electrical equipment which are common in a number of Continental countries, whereas there is, generally speaking, no corresponding compulsory scheme in operation in the United Kingdom. Hence C.E.E. recommendations are often not appropriate for implementation in the U.K., but are important to us in relation to our exports to the countries concerned.

A case in point is the C.E.E. specification for plugs and sockets. In this specification, standard dimensions are given with a view to ensuring interchangeability. The Continental pattern of plug and socket differs, however, from the British, with the result that the C.E.E. specification is not applicable to plugs and sockets for use in this country. On the other hand, the C.E.E. specification is of great assistance to British manufacturers who wish to produce articles specifically intended for the Continental market.

Why Two International Bodies ?

It may well be asked, why are there two international bodies, namely the I.E.C. and the C.E.E., both preparing specifications in the electrical field ? In brief, it may be said that the I.E.C. recommendations are, in the main, in the form of model specifications which, when translated into national specifications, could be used as the basis of a contract between manufacturer and purchaser. The C.E.E. specifications, on the other hand, are essentially test specifications drawn up from the point of view of a testing laboratory which has the responsibility, as an official approvals authority, of accepting or rejecting the articles concerned. The electrical industry of this country is keen to see that the U.K. point of view is adequately and correctly presented to both of these international bodies. We shall continue to follow all developments most keenly.

Commonwealth Collaboration

Another aspect of the international front requires special mention. That is, Commonwealth collaboration, which is a matter of outstanding importance. For one thing, exports to the Commonwealth form a large part of our total export trade in electrical goods, amounting to 60% of the total in 1953. Fortunately, the B.S.I. has a regular procedure for the interchange of draft standards with the other Commonwealth countries before they are published, and so we have an opportunity of the utmost value to comment on the specifications proposed in the other Commonwealth countries as they, also, have about ours.

For this and other reasons, the position to-day is that many of the basic electrical standards in the Commonwealth countries, other than in Canada (whose practice is specially related to the American), are either identical in content or very largely based on the corresponding British Standards. Indeed, in New Zealand many of the British Standards for electrical equipment have been endorsed by the New Zealand Standards Institute as New Zealand Standards. The same applies, though to a lesser extent, in Australia and South Africa. This situation has been built up mainly during a period when the U.K. supplied a dominant part of the needs of those Commonwealth countries. As indigenous industries develop and as competition from other sources of supply grows, it becomes more and more important that we should supplement our past efforts to keep the standards of all the Commonwealth countries in line.

This now begins to require more than routine procedures. A case in point and of recent experience concerns electric cables, where, despite the routine arrangements for exchange of proposals on new standards, it became evident that divergencies of standards requirements were developing. Fortunately the B.S.I. were able to arrange, last year, a special Conference in London on this matter among the Commonwealth interests. Then, the ordinary interchanges of correspondence were supplemented by direct round-the-table exchanges given by the experts concerned in the various Commonwealth countries.

The result was a wide area of agreement on general principles from which it is reasonable to hope that the tendencies towards divergence have been reversed. Discussions to review some of the detailed points arising from the recommendations of this Conference are taking place in the various countries, and a further Commonwealth Conference on this subject may be expected to take place before long. The procedure so followed in the case of cables, will, I hope, be a model for action in other sections of the electrical industry, and may well be the beginning of similar close collaboration between Commonwealth countries in many other industrial sectors.

The Canadian Market

The Canadian market for electrical goods is a large and important one which has special problems as regards standards. We have tackled these vigorously and it is partly as a result that our trade in electrical goods and accessories in Canada rose from £M1·7 in 1948 to £M9.5 in 1953. A similar increase was shown for many classes of machinery and apparatus incorporating electrical components ; for example, exports of machine tools rose from £M0.2 in 1948 to £M3.2 in 1953.

In Canada there are statutory requirements, calling for compliance with the Canadian Electrical Code and with the numerous standard specifications forming part of that Code. These standards are laid down in the interest of safety from fire and from shock and, of course, apply to Canadian products in the same way as to the products of all countries exporting to Canada. Compliance with the Canadian Electrical Code is mainly secured through the compulsory approvals scheme administered by the Canadian Standards Association (C.S.A.), in the laboratories in Toronto. Other parts of the Code are enforced through the provincial Electrical Inspectorates who examine installations on site.

In the past these special requirements caused difficulties for U.K. exporters, because of the delays encountered in securing approval of samples from the C.S.A. Laboratory in Toronto, or because of the uncertainty as to whether the local Canadian inspector would agree that the particular piece of equipment satisfied that inspector's interpretation of the Canadian Electrical Code. To deal with this situation a particularly interesting example of Canadian and U.K. collaboration was evolved. A scheme was introduced some four years ago and is now running very successfully, whereby British electrical equipment destined for Canada can be approved before it leaves the U.K. To enable this to be done, the Canadian Standards Association and the B.S.I. have joined together in providing, in London, an Agency to give on-the-spot advice and facilities for the testing and inspection of equipment to ensure that it conforms to Canadian requirements and will therefore be acceptable in the Canadian market.

Thus there are to-day Canadian approvals for about 450 types of British electrical equipment and a schedule of this equipment and the British firms manufacturing it is published by the B.S.I. and is being widely publicised both here and in Canada. This is of considerable interest not only to firms which are primarily electrical, but to others who supply goods incorporating electrical equipment.

What has been said above gives some brief indication of the importance attached by the British electrical industry to keeping well ahead in standards matters and of following very closely all the overseas trends, so that our export endeavours will be helped and not handicapped by the developments on the international front. This cannot be achieved without some substantial expenditure of resources, but the price of this constant vigilance is small compared with the trade which is at stake.

"Packaging and Movement" (*concluded from page* 467).

Conclusion

Packaging and movement are not only inter-related but to a large extent are inter-dependent. Whilst readily acknowledging the excellent work of the many packaging research laboratories throughout this country and the development work constantly being undertaken by handling and transport bodies, it is for consideration whether in fact there is an effective liaison between the two at all levels of industry.

Possibly here is an opportunity for an organisation such as the British Standards Institution to study the possibility of co-ordinating the results of both branches with a view to expediting the adoption of standards, dimensional and otherwise, capable of acceptance not only in Great Britain but in the countries and on the trade routes of the world.

Clearly, we have by no means exhausted the possibilities of increasing productivity in the packaging and movement fields, and the development of a technically sound and economic package for movement on a modern handling and transport system will increase the competitive value of Britain's products throughout the world.

PACKAGING AND MOVEMENT

by R. E. HUFFAM, M.C.

R. E. Huffam

Mr. Huffam, who was educated at Giggleswick School, Yorkshire, served with the Cheshire Regiment during the 1914/18 War, and was awarded the Military Cross. After the War he joined Joseph Crosfield & Sons, Ltd., of Warrington, where he remained until 1923 as Assistant to the Works Director.

He was subsequently appointed Chairman and Managing Director of Wilkie & Soames, Ltd; Director of Joseph Crosfield & Sons and, later, Technical Director of the same company. In 1930 he became Chairman of Lever Brothers, Port Sunlight, until 1938, when he came to the Head Office in London. During the Second World War he served in an advisory capacity with the Ministry of Supply and the Ministry of Aircraft Production. In 1941, he joined the Board of Unilever, Ltd.

Mr. Huffam is Chairman of the Soap Makers' & Fat Splitters' Federation; President of the Soap, Candle & Edible Fat Trades Employers' Federation; and Chairman of the Finance Committee of the British Standards Institution.

ALL productive economic processes consist basically of *movement* and it is the method by which these processes are performed which determines to a great extent our economic advancement.

Movement is the term generally ascribed to the cycle of operations which are the basis of manufacturing productivity, i.e. extracting or procurement, processing and distribution, the latter embracing handling and transportation. In an effort to reduce the various costs attributed to this cycle of operations, considerable thought and energy have been expended over the years by many national organisations and private companies, and in this Paper I want to discuss specially the two aspects referred to in the title, i.e. packaging and movement.

Packaging I define as " necessary protection for certain finished articles to facilitate their handling and transportation".

Movement for the purposes of this Paper, I propose to use in the narrower sense and define it as " the handling and transportation of commodities from their original procurement to their delivery to the customer".

My object today is to draw attention to the techniques which are being progressively developed to ensure the arrival of finished products at consumers' premises in " factory-fresh " condition—by whatever means of transport is used. When one considers that in the United Kingdom approximately 14% of the national income is derived from transport—of which nearly half, or £775 million, is for the transport of goods alone—then *prima facie* there is a case for the *continued* scientific study and development of techniques in packaging and handling jointly, by the users and providers of transport alike, with a view to achieving further increased productivity.

I say " further " because from the official statistics in respect of 1953, we know that industrial production rose by 6% last year and the output per manhour by almost 3½%—and I now quote—" and was particularly noticeable in the building industry, in the distributive trades, in transport and in agriculture". The fact that exports rose by 3% is a further incentive to industry to pursue these studies and developments in packaging and handling.

In this Paper, I propose to deal with the technique of the packaging and handling of the finished products of my own Company within the U.K. and for the export market, and thereafter to discuss the movement of goods nationally and internationally, from the point of view of ensuring that the goods are delivered to the consumer in " factory fresh " condition.

I would emphasise that handling of raw materials is equally a problem worthy of the closest consideration, but since in many cases bulk-handling is often more appropriate—at least in my own Company—it scarcely falls within the scope of this Paper.

Technique of Packaging

If our aim is to be the delivery of our products to the consumer in " factory fresh " condition, and I am certain that nothing less will do, then the problem for the packer is how to ensure that his packages or containers are correct in design and construction for the commodity to be packed therein. He must also ensure that they are correctly designed for the transportation hazards likely to be encountered between the point of manufacture and the point of final delivery.

The packer must also take into consideration any regulations laid down for the packaging of dangerous goods by Customs, transport or shipping authorities, both in this country and in the overseas country to which the goods are to be consigned.

Thus every commodity may present a separate packaging problem. Some commodities require partitions, trays and the like; some are seriously affected by heat and cold and some contribute to the strength of the package, whilst others are so fragile that all the required strength must be in the outer container. In some cases, the pack must have an attractive appearance and thus serve a valuable purpose as an advertising medium.

In the Unilever concern, practically every type of packaging material is used in some form or other, whether it be bottles, tins, cartons, wrappers, collapsible tubes, plastic sachets, paper or hessian sacks, fibreboard cases or wood boxes. It may be interesting to note that for the inwards delivery of these materials we adopt the most convenient form for each particular item and the following are some examples of this :-

1. *Bottles* arrive in the sectionised fibreboard outer containers which are eventually to be used for the delivery of the packed product to the customer. The outer container is thus used twice. This method is also used to a certain extent for tin cans in the processed food industry.

2. *Fibreboard* cases (not required to carry empties inwards) are delivered in the 'flat' in suitable bundles, and where it is convenient and the facilities are available, they are delivered in unit loads and if possible on pallets. This form of handling to which I will refer later has many advantages, both at the case-maker's factory and in our own factories.

3. *Processed materials* from which the cartons are made—for we print and make a lot of our own cartons—are delivered in large reels, which may weigh in some cases well over a ton.

4. *Sacks,* which are used to a very great extent for animal feeding stuffs, are delivered in bales to the point of use.

Design and Selection of Consumer Package (or Inner Container)

The consumer package, which is the actual container in which the product is sold to the user, must be correct for the job in hand from the point of view of cost and suitability for use with its particular contents.

There are many factors affecting the selection of a package of which the following may be considered typical examples :

The choice of a particular material for the protection of any given commodity may be influenced by the characteristics of the product concerned; for example, one or more of the constituents of a product might react unfavourably on the type of packaging material used. Aluminium was one such example of this. In certain cases modification of the product to prevent chemical reaction was necessary before aluminium could be used. In other cases it was possible to protect it by a plastic or wax coating. By these means aluminium became a suitable substitute for the more expensive metal, tin.

A great number of products which are packed have some particular or peculiar characteristics. One product may tend to pick up moisture from the atmosphere or another product tend to dry out. Light has the effect of oxidising certain products and in this case, of course, a transparent container cannot be used. With other products, it is necessary to allow them to breathe and care has to be taken to ensure that the package will permit this. In many cases the effect of these characteristics may not be serious, but where it is, adequate provision must be made in the packaging material.

Having chosen the right packaging material and made it into the consumer package, consideration must be given to identification and application for use, and this very often has an effect on a most important point, the final weight and dimensions of the package.

Outer Container

The design of the outer container is usually determined by the most suitable sales unit and in this connection it is prudent to consult the packaging, handling and transport experts, particularly in regard to questions of suitability of dimensions (which affect economic stacking and handling, also the safety of the goods), weight, and economy before any final decisions are arrived at, e.g. where duties are chargeable on the outer packaging, special consideration has to be given to the effect which this will have on the final cost of the article. In some cases for export, due regard has to be paid to the customer's requirements where he may want the commodity packed in a certain type of outer which will be of use to him for other purposes, including resale, and which can be imported duty-free as a necessary container. Compound lard shipped in galvanised iron pails and biscuits shipped in galvanised iron tanks are just two examples. Again, to certain markets it is essential to ship in fibreboard cases and in others the customer demands wooden cases. It is not generally appreciated what effect these factors have on other links in the chain of distribution.

The other important step, of course, is to determine the best form in which the consumer package itself should be protected from the hazards of transport.

In the United Kingdom, for most consumer goods the fibreboard case is the usual form of outer con-

tainer and by and large withstands the rigours of our handling hazards.

For exporting goods overseas the fibreboard container is also being used in increasing quantities, largely because of the saving in cost as compared with wooden cases or crates and also on account of the further saving on import duty where this is levied on the gross weight. For many commodities the fibreboard cases are undoubtedly an excellent form of packing, but they should not be used indiscriminately. Before deciding on their use, consideration should be given to the precise nature of the requirement in regard both to packing and movement. For example, if the contents are susceptible to pilferage, is sufficient protection provided by a case of this kind? Or, if the final destination is many miles inland in undeveloped country overseas, consideration would require to be given to the effect of repeated handlings on a case of this design and construction.

The switch-over from wooden cases to fibreboard cases is one which I think merits attention because of the issues involved. Fibreboard cases are cheaper and exporters generally take the view that they are just as strong as wooden cases and they save shipping space. Ship-owners are not so happy, I believe, about these changes. They contend, rightly or wrongly, that exporters do not always use a fibreboard sufficiently strong to withstand the rigours of transport by sea. The fibreboard case involves the shippers in stowage problems and gives them a lesser freight if they continue to charge the same rate for the goods which were previously carried in heavier wooden packages. In many cases, the ship-owners have raised the rate of freight on the fibreboard package so that their gross rate of freight will remain the same as for the heavier wooden package. Thus the economy which the exporter had looked for in this direction has been largely nullified.

A possible alternative to the normal fibreboard case or wooden case is one made of plywood. We have been able to develop a satisfactory container of this type, of adequate strength, at a lower initial cost than a similar ordinary wooden case. It is also cheaper to transport and can be made pilfer-proof by the use of special rivets. There are, therefore, several alternatives for export outer containers each of which has certain merits. The shipping conference system, which has many benefits for both shipper and ship-owner alike, could, I think, look more flexibly and imaginatively on these problems to assist shippers in their endeavour to reduce costs.

Where it is possible, exporters try to market their goods in standard packs of the same weight and measurement. Where they can achieve this in certain markets an opportunity is then afforded to convey the packages to the docks on pallets, and if these pallets are standardised to fit the loading trays used by the stevedores, as they well can be, then economy in loading costs would certainly result.

The packing of dangerous goods to be carried by sea is governed by special regulations set down by law and the shipper must sign a declaration that he has complied with that law before he tenders goods for shipment. The thickness of metal for drums, the size of packages, the thickness of wood, the type of glass container, the type of packing material to be used, the actual weight of the package are provided for in regulations, as are penalties for evading them.

It is also important to note that each foreign country has its own regulations applicable to packing and the exporter must be knowledgeable of the requirements in each case. For instance, straw may not be used to pack goods destined for certain countries and for others the specific type of wood wool or shavings which can be used is also laid down.

Standards as Applied to Packing Materials

A great deal of work has been done on the standardisation of package containers, both by individual concerns and by the B.S.I., whose British Standard Packaging Code No. BS 1133 is well known. Additional specifications have been laid down as, for example, in the Classification Regulations of British Railways, especially regarding the fibreboard cases which they will accept for conveyance at Company's risk. These regulations are in themselves standards of a kind, and lay down minimum requirements for the thickness, tensile strength, etc., of the fibreboard to be used, related to the weight of the contents, and to the type of case, e.g. one-piece, three-piece, etc. The fibreboard must also be water-resisting with the outer surface waterproofed.

Perhaps the best known use of a standard container is the tin can used for processed foods. This form of standardisation has enabled manufacturers to set up most efficient high speed plant, with a resultant decrease in the cost of the container produced.

In regard to cartons, standards other than those which individual concerns have set up themselves do not exist. Most carton designers, however, make the most economical use of cartonboard by utilising the full deckle of the cartonboard manufacturing machine. The main advantage to the user of cartons of unit size lies in the fact that it allows for standardisation on the carton handling plant, and eliminates considerable expense which would be incurred if the machine had to be altered from time to time to take different-sized cartons.

Now a word on hazards. Science is constantly being applied to the study of many hazards encountered by packages in their movement throughout the world and, no doubt, considerable progress is being made wherever the hazards are known. As in most things, however, the unknown or unpredicted hazards present the problem, and in view of this I feel sure further study should be given to the conditions likely to be encountered throughout the ENTIRE journey cycle of a product and not just part of it. Hazards *en route* might include anything from adverse climatic conditions to poor or disastrous handling techniques. Packaging each commodity must therefore be considered in the light of the conditions to which it will be subjected.

But lest it be thought that we must go on indefinitely building up huge barricades around our

packages, let us turn to the other complementary aspect to which I have already frequently referred—what *is* being done to protect the package in transit?

Movement Technique

Movement has been described as the common denominator of every factory, and indeed of our lives. It is certainly vital to trade and industry, and profoundly affects our very existence.

In Unilever a not inconsiderable volume of products passes daily by road and rail between our factories and depots. In the case of railway movement, which is mainly from private sidings, we are responsible for the loading and in so doing must have regard to the possibility of movement due to shunting shocks and transit oscillation *en route*. You may be interested to know that in addition to overcoming this problem, we have more recently been successful in transporting pallet loads of fibreboard cases in railway vans. In unitising the loads on pallets, many unnecessary handlings have been eliminated. The pallets are placed in suitably partitioned vans and with the aid of British Railways' standard packing materials, loads of up to eight or nine tons can be carried in such a fashion as will permit immediate removal of the pallets from the van on arrival. In passing, I would say that we are regularly loading and unloading pallets from these vans at the rate of approximately one ton every two minutes.

Equally, on the road side, palletisation of our fibreboard cased goods presents no difficulty.

For the major portion of Unilever products, we use the normal type of rail and road vehicles. A few of our products, however, require special facilities, notably ice-cream and frozen foods, which need insulated and refrigerated vehicles and cold storage so that they can be kept at a very low temperature until they reach the customer.

For most of our finished products, e.g. soap, margarine, canned foods, toilet preparations, etc. we employ a depot distribution system throughout England and Wales, Scotland and Northern Ireland. The commodities are sent in full vehicle loads by road and rail and, to a lesser extent, by coastwise steamer, to about 60 depots operated by our warehousing and distributing company, S.P.D. Ltd., where they are stored, and the orders amalgamated so that the customer receives the products from several factories in one delivery performed by our own staff.

Another important range of our products, i.e. bagged animal feeding stuffs, are despatched from the mill direct to customers, some of whom have their own depots, generally at railway stations.

For the distribution of small consignments of toilet products to chemists, etc., we are experimenting with deliveries by vans specially designed and fitted with racks and trays. The orders of individual customers are placed on the trays without the normal outer containers, and the customer is able to check the quantities visually and remove them from the trays which are replaced on the vehicle racks and returned for further use.

Transport Containers

Whilst discussing handling and movement we must not overlook the great development, for a wide range of products, of transport containers, by the railways and traders, and to a lesser extent by road transport and shipping companies.

Transport containers enable goods to be conveyed by railway with a minimum of outer packing. They also enable the railways to give the door-to-door service which is normal with road transport, and which can otherwise be given by the railways only where both the forwarding and the receiving premises have rail-siding connections.

The door-to-door service obviates the necessity for packages being handled during the journey, and therefore reduces the risk of damage.

Charges raised by the railways are related to the net weight of the package, and as the containers are placed into general circulation at the receiving end after being unloaded, the question of returned empty charges does not arise.

The containers are loaded at the suppliers' premises and are moved by road vehicle to the railway station, where they are lifted by crane on to a rail wagon. The procedure is reversed at the receiving end.

The use of containers in this way reduces the cost of the provision of packing material, eliminates carriage charges on its weight and avoids the cost and inconvenience of returned empties.

The railways supply insulated containers which with an added refrigerant, usually dry ice, are suitable for the conveyance of ice-cream and frozen foods.

Railway containers are now used extensively for inland traffic and they are also employed to an increasing extent for overseas traffic, where the same advantages accrue though the method of charging packages rather than to the gross weight of the container traffic on cross-channel steamers and on foreign railway systems varies. In most cases, however, the charges are related to the weight of the transport container and its contents.

Cross-Channel Ferry Services

A further means of giving a door-to-door service without intermediate handling of goods are the Continental ferry services. The train-ferry services for railway wagons between this country and the Continent have, of course, been in operation for many years (Harwich-Zeebrugge, 1924, and Dover-Dunkerque, 1936), and are used for a wide range of commodities including perishable foods.

A much later development is the ferry service for road vehicles operating between Preston and Larne with tank-landing craft. The provision of a similar service between this country and the Continent has been proposed but has not yet been introduced.

Materials Handling—Some Unilever Methods in U.K.

For many years now steady progress has been made in the field of materials handling in this country, and within my own Company opportunity has been taken

whenever possible to eliminate unnecessary handling and reduce fatigue on the remaining essential handling work. Many devices have been responsible for the progress made to date including work simplification, re-siting of plant, increased use of flow-line system in production, improved use of gravity equipment and a variety of mechanical handling devices.

In the latter category, perhaps the most remarkable advance has been made in the fork truck and pallet system of mechanical handling.

As many of you already know, in the soap, margarine and canned food side of our business we have over the last few years progressively introduced palletisation for the handling and transportation of these carton goods within and from our factories, through to depots. There are many advantages in doing this of which the following are important:

1. Simplification of the handling system within the factory or industry concerned.
2. Improved utilisation of transport vehicles due to reduced terminal time. Already road and rail vehicles can be loaded at the rate of approximately one ton every two minutes and can be discharged at suitably equipped destinations at about the same rate.
3. Palletised loads normally lend themselves to easy stacking; storage and stock-taking is simplified; damage is almost eliminated and the onward handling to wholesaler, retailer or even the consumer is considerably simplified, especially in those cases where complete pallet loads can be accepted.
4. This leads to reduced fatigue of employees concerned, per ton handled.
5. It gives a better utilisation of manpower. Mention should be made here of the employment of palletisation in connection with the handling of raw materials and finished products in bags. In many instances, the bags after being palletised are tiered and stored in the same way as cartons and individual handling of sacks is thereby reduced.

From my earlier remarks, you will readily appreciate my views in regard to the standardisation of pallets and the ever-increasing impact which this is making, or will make, upon the design and dimensions of many of our packages. Already there are instances where production and sales executives are recognising the economic necessity for adjusting package sizes to suit certain types of pallets.

The B.S.I. some time ago recognised the need for pallet standards and attached so much importance to it that they established a Technical Committee specially to deal with this matter. Few Committees have been faced with so many extraneous factors when considering standards, of which the varying size of road and rail vehicles, road widths, etc. are but a few. In spite of this, or perhaps because of it, a British Standard for pallets for materials handling will shortly be promulgated.

The object of this British Standard is "to standardise a series of pallet sizes and capacities which are acceptable to transport organisations and convenient for transport and storage within individual organisations, so that palletised unit loads may be moved from manufacturer to consumer with a minimum of handling and by means of as wide a range as possible of handling equipment". Six sizes, giving an opportunity of wide application, have been specified.

Incidentally, two of the six sizes referred to have been adopted by the International Standards Organisation and others are under consideration by that body. Thus it will be seen that a wide measure of agreement has been reached not only nationally but internationally, particularly with the countries in Western Europe.

Also in the United Kingdom, an important step was taken in November of last year by the British Railways when they initiated a free weight allowance for pallets (based on pallet sizes recommended by the B.S.I.) and I believe independent road hauliers are coming into line in this respect also.

Before turning to movement overseas, one very important outcome of standardisation of pallets in Britain is the extent to which we as buyers can now obtain our supplies (raw materials, ingredients, and not least of all packaging materials) on pallets of a size similar to that which we ourselves use. This interchange is the outcome of co-operation with suppliers and transport undertakings at many points and it enables us to enjoy the full benefits of palletisation where this system of handling is appropriate to our needs. There is still room for further extension of interchange facilities and many industries look forward to the increased use of standard pallets for this purpose.

In regard to shipping, because of the diverse nature of general cargoes, mechanical handling has not developed so rapidly at the ports as in industry generally. If palletisation is to benefit stevedores materially, logically it must start in the factory and follow on throughout the channels of distribution to ship's side or further.

The first reaction of opinion in shipping circles is, I believe, that goods offered for sea transport on pallets, if retained on pallets for the voyage, would reduce the stowage capacity of the ship by something like 20%. Even if this be true, there should be a compensatory advantage in the quicker turnround which could be achieved by handling in this way. It has also been pointed out that unless the pallets were expendable they would require to be returned empty. From the exporters' point of view this latter point may be true, but I think it is for consideration by the exporters and importers jointly, in all countries concerned, as to whether or not the empty pallets could be utilised on the return journey. There may be many instances when this might not be so, but equally there must be many ships bringing cargo into this country from overseas which must in many cases have been palletised up to ship's side at port of origin, only to be de-palletised into the ship's hold for the voyage and no doubt re-palletised on arrival in this country. In any event, the acceptance of

International Standards for pallets will go a long way towards solving these difficulties.

One looks forward to the day when a pallet load of goods can be carried from the factory floor to the docks, loaded into the ship, and the same pallet kept on board with its load until it is discharged at destination port and then, still as a unit load, conveyed to its up-country destination. The saving in handling costs would be immense. In still waters this type of transit is taking place, but for the ocean voyage on the high seas, where storms and stresses are greater, many problems of stowage will need to be overcome before the export trade can take full advantage of palletised loading and carriage. The problem is, however, not insuperable and what has been achieved on the Great Lakes and round the still waters of Denmark and in the Mediterranean may yet be achieved on long ocean voyages and the palletised load become the rule rather than the exception.

For exporters the greatest problem is not always how to pack, but rather how NOT to pack. In other words, one strives for economy in many export trades by endeavouring to ship in bulk and economise thereby in freight, duties, and the outer package itself. This is particularly the case with vegetable oils, cement, feeding cakes, and motor cars. If, with safety and without harm to the commodity itself, one can do without packing in any form, then great economies can be and, indeed, are being achieved; that, if I may say so, is something an exporter should have constantly before him, for therein lies the opportunity of cutting his c.i.f. price in a market that otherwise he might lose.

International Field

There is, however, considerable evidence to show that more thought is being given to the requirements of efficient materials handling, both on the American and European continents as well as in this country.

Carriers have in many cases taken a lead in the development of new methods and examples of this can be seen in Britain, where the railways are building new vehicles for carrying pallets; marine architects at home and overseas are designing ships with holds more suitable for palletised traffic, and aircraft designers are studying the possibilities of carrying unit loads on pallets (or detachable container/pallets) in aircraft, on a commercial scale.

It has long been recognised on the Continent that standardisation of equipment between the Continental countries is an economic necessity and many important bodies, governmental and otherwise, including the International Chamber of Commerce and the International Container Bureau, have been vigorously tackling the problem in the last few years.

The International Chamber of Commerce, on behalf of users internationally, is opening up discussions with the transport providers' associations, rail, road and inland waterways, on matters of principle affecting palletisation and on problems of joint concern to users and providers.

In support of this, national transport undertakings in European countries have played an important part in recent times. The contribution of the Swiss, German, Finnish and Dutch Railways in granting free carriage of pallets is a marked and emphatic recognition that the pallet has become an important tool of industry, destined to play a vital role in the general campaign for increased productivity in Europe and elsewhere.

Realising the tremendous economic advantages of "throughout movement on pallets", a technical committee was set up by the International Standards Organisation and has been studying the question of the adoption of standard pallets for use internationally. Already two sizes have been adopted, namely, the 32″ × 48″ and the 40″ × 48″, and three weeks ago, at a meeting of this body in London, a pallet size 32″ × 40″ was also recommended for adoption by the member countries concerned.

Advantages of Standardisation in Relation to Packaging and Handling

From the foregoing it is clear that great benefits are to be derived from adapting the dimensions and design of packing materials to suit the pallet sizes recommended by the British Standards Institution or, in the case of international traffic, the International Standards Organisation.

Unit packages guarantee a very effective space utilisation when built up or tiered brick fashion and whilst it is appreciated that all articles manufactured in this country cannot always conform to this brick shape design, it is an ideal or, if you like a *standard,* well worthy of serious consideration.

Many types of wooden cases and crates are provided with girth battens on top and bottom sides. If these battens are located at a pre-determined position, then the battens will coincide when the boxes or crates are tiered one upon the other. This simple arrangement enables the cases to be lifted by the forks of a fork-lift truck and to be stacked or tiered to considerable heights.

To sum up, therefore, we can say that the advantages of standardisation in respect of packaging and handling may be stated as follows :-

1. It encourages a common policy in regard to packaging and handling techniques.
2. It simplifies packaging and handling equipment.
3. It encourages the increased standardisation of associated components.
4. It provides a basis for forward planning in regard to movement, warehousing and traffic policy generally.

These in turn produce savings for the producer, the transporter, the warehouse keeper and finally what is more important a lower price for the consumer.

(*concluded on page* 461)

PRODUCTION CONFERENCE

SESSION IX

WORK OF THE BRITISH STANDARDS INSTITUTION AS AFFECTING EXPORT TRADE

by H. A. R. BINNEY, C.B.

Mr. H. A. R. Binney

Mr. Binney is a B.Sc. (Eng.) London University. His practical engineering training was received at the Royal Dockyard, Devonport.

He entered the Board of Trade in 1929, as an Examiner in H.M. Patent Office. Between 1933 and November, 1950, when he was appointed Director Designate of the British Standards Institution, Mr. Binney performed a wide range of administrative duties in the Board of Trade. For the first two years he was concerned in the Commercial Relations and Export Department with various international negotiations, especially the Trade Agreements with Scandinavia and other countries. Subsequently, in the Industries and Manufactures Department, he had close contacts with many branches of United Kingdom industry and trade.

In the early part of the Second World War he was Controller of the Import Licensing Department and was later concerned with war-time controls in a wide range of industries handling consumer goods; it is interesting to note that he was the official responsible for initiating the utility furniture scheme. In 1944 he became head of the first Engineering Division of the Board of Trade. In 1947, he was made an Under-Secretary and in this appointment was in charge at the official level of the government work concerned with all the textile and clothing industries—and with clothes rationing. Two of the last duties performed by Mr. Binney at the Board of Trade were to lead the United Kingdom Delegation to the International Cotton Advisory Council meeting held in Washington in June, 1950, and to take the Chair at the Wool Study Group Conference held in London, in September, 1950.

Mr. Binney became Director of the British Standards Institution in December, 1950, on the death of Mr. Percy Good.

THE total effect on British export trade of the work of the British Standards Institution is almost impossible to assess. There are few products which do not enter into export trade and few for which applied standards do not exist. These standards determine much of the competitive strength of the goods concerned. On the one side, they make for the most economic production,—i.e. for the provision of goods more cheaply and more quickly and with speedier servicing facilities. On the other side, they give the user assurances of quality, performance and accurate replacement.

When considering the economic effect of standards on production, we must remember not only those standards which directly affect the product itself, important though these are. Every production organisation is more or less concerned with a wide variety of other standards: those which deal with the building and layout of the factory; the basic standards for engineering generally—limits and fits, screw threads and so on; the standards which have affected the supplies of heat, power and water and their installation; the correct grading by standard test methods of raw materials to ensure the quality of the end-product; the many standards which deal with the transport of raw materials to the factory and the movement of the finished product to its destination—and not least those more " abstract " types of standards which have laid down uniform drawing practice, use of terms, definitions and the like.

But it is with the second consideration—how British Standards are suited to the needs of the potential customer overseas—that this Paper is primarily concerned. With this aspect the British Standards Institution is involved daily.

There was a time when British industry could afford largely to ignore the standards of other countries—in fact, to " standardise " for export on a purely national basis, and to assume that British Standards would either be adopted as the national standards of the consuming countries or at least would be fully acceptable—and this despite the metric system in Continental countries. But this convenient state of affairs has long since changed. As industrial skills and potentials have developed overseas, so have the means to establish national standards, and this not least in countries—particularly those of the Commonwealth—which previously depended on the United

Kingdom for their main supplies of a vast range of capital and manufactured goods.

This development is still accelerating. In some countries, too, standards are made compulsory through statutory regulations; in some others the situation is complicated by the fact that varying regulations are laid down in different states or provinces within the one country (as for example, in Canada and Australia). To-day, as always, the nation which can influence the standards of international trade can for that very reason enjoy a special advantage in that trade. The moral is obvious for a country which is traditionally the greatest exporting nation of the world. While the circumstances in which our influence can now be exerted are radically different from those of half a century ago, we must be no less adept in meeting those changed conditions.

This country's effort on these matters is centralised and focussed through the British Standards Institution under three main heads:—

i. Supply of information about British Standards to the overseas markets of the world.

ii. Representation of the British point of view at international standards meetings and conferences.

iii. Influencing the preparation of British Standards so that they best suit the requirements of export trade.

Information Services

The first head is largely a matter of ways and means. We aim to secure the widest possible dissemination of British Standards overseas—both by actual sale and by making copies widely available at reference points abroad. The success of this effort is best known by the fact that yearly sales of British Standards to overseas purchasers have risen to a level of almost 250,000 copies. To provide ready reference points abroad, full sets of British Standards are held and kept up-to-date by each of the standards organisations throughout the world and by many universities and technical bodies; by British Embassies and Legations, the U.K. Trade Commissioners and by representatives of the Crown Agents for overseas governments and administrations (in all, nearly 200 centres in 77 overseas countries). Nevertheless, there is criticism that British standards are less well known than they should be in some important overseas markets, and we are again reviewing this question to decide what steps can be taken to improve both knowledge and availability of our standards.

It may be that there is room for some extension of the special provisions we make in Rhodesia and in the Argentine, of having a local office activated by committees of British businessmen on the spot. It may be that we should adopt a still more vigorous policy in offering sets of our Standards to agencies abroad. Certain it is that we should be glad to have the further advice and help of interested British business and industrial men on this subject, and in particular their guidance on the different conditions which they encounter in different parts of the world.

It is also, of course, a routine task of the B.S.I. to provide an information service on standards developments overseas. All the thirty-three standards bodies in the various countries interchange information about the standards they publish; and all overseas standards are publicised in B.S.I.'s "Monthly Information Sheet", of which 30,000 copies are distributed each month. Reference copies of all overseas standards are available for study in the B.S.I. Library, with a translation service immediately available. The link with standards developments in Commonwealth countries is even closer: we receive early notice of all the work they are starting, and drafts of all their standards are available before publication for comment by interested and qualified people in this country.

Making Britain's Voice Heard

Representation of the British point of view in the international standards field grows in activity and importance. It is convenient to consider first the position among the Commonwealth countries, where particularly close relations are maintained and fostered.

First there is the regular routine for exchange of information, including the circulation between the Commonwealth countries of drafts of all proposed standards, so that inter-Commonwealth comment on those proposals can be considered before the draft standards become finalised. Further, a number of special conferences of Commonwealth Standards bodies have been held since the War, in order to ensure substantial alignment of outlook and operating policy. Such special conferences will be convened again from time to time.

As to the effects of this collaboration, it is of vital commercial importance that many of the independent national standards adopted in Australia, New Zealand, South Africa, India and Pakistan are either identical in technical content with or are very largely based on the relevant British Standards. Canada is in this connection a special case, because her standards are inevitably related more closely to American than to British practice. Mr. Maxwell Buist's Paper has described the special arrangements which have been devised by the B.S.I. to assist our electrical exporters to meet Canada's particular (and statutory) requirements. Similar arrangements have also been made recently for the inspection and approval in this country of pressure vessels destined for export to Canada. We shall lose no opportunity to extend a service of this kind to other ranges of equipment and, if necessary, in respect of other areas of the Commonwealth, if there is a demand for it and if similar arrangements can be settled.

This special association of the Commonwealth countries on the matter of standards is of value to each of them. It is a collaboration of equal partners with no language difficulty, with much the same origins of technical thinking and with a mutual desire to increase the volume and the efficiency of the trade passing between them. It is a very valuable association which we must always be intent on fostering; and in this inherently favourable environment, it will

greatly help this aim if British exporters will keep a lively watch on standards developments which affect particular branches of export trade with the Commonwealth, so that the right approaches can be made in good time to prevent the development of divergencies of thought and action. An excellent illustration of what can be done in this way was the Commonwealth Cables Conference arranged by B.S.I. in London last year, and dealt with in appropriate detail by Mr. Buist in his preceding Paper.

It is right to record, too, that this specially close link-up within the Commonwealth in no way prohibits later alignments and agreements which may prove practicable in the wider international sphere.

Outside the Commonwealth

This wider sphere of work is conducted mainly under the aegis of the International Organisation for Standardisation (ISO), with which is associated, on the electrical side, the International Electrotechnical Commission—more compactly known as I.E.C. Mr. Maxwell Buist's Paper gives some detailed account of the I.E.C. and of the United Kingdom's part in its work.

Membership of ISO covers practically all the industrialised countries of the world. Its fundamental purpose is the expansion of international trade by promoting the interchangeability of goods, equipment and machinery, by the speeding up of transport through standard handling apparatus, and like projects. This work has developed rapidly in recent years, and there are now some 80 active ISO committees, of which the B.S.I. holds the secretariat for about 20.

In contrast with the comparable body which existed before the War—the ISA—the ISO has had the benefit of active co-operation from the United States, a factor which is clearly of the utmost importance. The ISO does not issue " international standards " which have independent validity, but rather aims at recommendations, the essence of which can then be embodied in the national standards of collaborating countries. Even in the absence of detailed recommendations, which may take some time to secure, general principles are often agreed in the discussions of the various committees. These can guide the national standards bodies and often serve to obtain a very useful degree of alignment, and the development on comparable lines of independent national standards.

Indeed, the general case is not so much that we wish to achieve close identity of view on technical details which may be embodied in standards, but rather to ensure that national standards do not constitute artificial barriers to trade between nations, so that competition can take place on the proper basis of the quality or performance inherent in the goods themselves. It is proper to emphasise, in this context, that in these international deliberations all that is reasonable is done to see that ISO recommendations are not opposed to British practice and techniques.

The scope of the current ISO programme is, then, very wide. By way of examples, some of the ISO Conferences which have recently taken place on the premises of B.S.I., have dealt with such diverse subjects as:—

- ***Coal*** (methods of grading and evaluation);
- ***Steel*** (methods of test and the calibration of testing machines);
- ***Electrical switchgear*** (alignment of standards for components and preparation of a Code of Practice for maintenance);
- ***Screw-threads for Glass Containers*** (where the effort is aimed at bridging the gap between the metric "Continental" practice and the inch-standard observed throughout the English-speaking world);
- ***Machine tools*** (investigations as a preliminary to recommendations on components of lathes and milling machines and preparation of a general code for the testing of machine tools);
- ***Textiles*** (methods of test for colour fastness); and
- ***Concert Pitch*** (to facilitate not only international trade in musical instruments, but a unified basis of performance in all countries of artists and orchestras).

All these and many similar movements attract to the forum of the B.S.I.—and equally to those of other nations—technical and business leaders from all over the world; and the aim throughout is to promote the effective flow of trade in all directions.

Some Further Examples

A particularly interesting example of what can be done, and how, concerns laboratory apparatus, medical supplies and the like, where accuracy and reliability of the goods and their suitability to the conditions and requirements are vital in more than one sense of the word. A recent agreement deals with the principles of construction and adjustment of volumetric glassware, and work is being done in the same international committee on specifications for thermometers and hydrometers, on a series of sizes for interchangeable conical ground-glass joints, as well as on the terminology of the whole subject.

A very special importance attaches to the well-conceived efforts by representatives of eight nations to secure substantial alignment in the dimensional features of blood transfusion equipment, and the British Standard recently published embodies the agreement so far reached on the ISO Technical Committee concerned. Valves for medical gas cylinders are also under discussion.

Transport and packaging offer fruitful fields for international understanding. Here might be instanced the many aircraft subjects currently under consideration in ISO—e.g. identification of aircraft pipelines, voltages for aircraft electrical systems, storage battery connections, external fittings for towed aircraft, ground air conditioning connectors, pressure cabin ground test connections—all with the very practical objective of securing the speedy and uniform servicing of the world's air-fleets wherever they touch down. An existing British Standard is also forming the basis of ISO discussion on general requirements for aircraft instruments and electrical equipment.

International standardisation of sizes of pallets for fork lift trucks, on which substantial agreement has been reached, should, as it develops further, greatly simplify transport of goods across frontiers and seas and thus reduce cost. One of our biggest overseas trading concerns has estimated that, with older methods of transit and shipment, a given load may have to be broken down and reassembled no fewer than twenty times between an inland factory in this country and an inland customer in a European country such as Italy. But that same load, if mounted on one of the standard international pallets, could pass from a despatch department here and thence by road, rail and sea transport, right to its ultimate destination—without being broken down once on the whole journey. The saving of time and cost and the reduction in the risk of loss and damage are clearly substantial.

Another not quite so obvious field where agreed international standards can be of major significance for exports, either from the U.K. or from other parts of the sterling area, is that of raw materials. For instance, test methods which are now being considered will enable raw rubber to be assessed for its suitability for various purposes no less conveniently than the competing synthetic product. Of considerable significance also is the ISO work on a code for acceptance of boilers. This is a case where an effort is being made to reconcile the American specifications with the otherwise fairly widely accepted British Standard.

Reference should also be made here to the efforts to simplify the international language of industry and trade—to ensure that terms, symbols, drawing practice, etc., are understood as between one country and another and are as nearly as possible uniform. Many of the ISO Technical Committees are including in their work the preparation of glossaries of their particular subject. An interesting example concerns the names for chemicals used for pest control. International discussions are being based on a recently-published British Standard, which reduces to simple and usable words the polysyllable technical terms employed by professional chemists to define these compounds: in the B.S. shorthand language "ferric dimethyldithiocarbamate" becomes simply "Ferbam." Another ISO committee is adopting a number of the underlying principles of the recent and very important British Standard for drawing practice. This standard incorporates tentative agreement reached between America, Britain and Canada (the "ABC" countries).

These examples illustrate the scope of the technical work being carried on in ISO and this country's part in it. The ISO central organisation at Geneva is in touch with a number of other international bodies whose interests at times touch the standards field—including the Food and Agriculture Organisation, with its interest in agricultural machinery, etc., the International Union of Railways, the I.C.A.O. and others; while the B.S.I. is in regular touch with the United Kingdom interests concerned with these bodies.

The O.E.E.C. performs a rather special role in standards work. The main function of its committee dealing with standards matters is to promote activity on projects of particular interest to European trade, and to keep in close touch with the ISO and IEC on such projects. We are active on this committee. Its work has led to some useful interchanges, and missions to the U.S.A. under its aegis have gained useful knowledge of American methods and techniques in simplifying and standardising production. The financing of study and investigation sponsored by the O.E.E.C. committee is now administered by the European Productivity Agency; and a new scheme for investigation of modular co-ordination in building will be financed by funds from the Agency. Here again, this country is playing a major part in the scheme.

British Standards and Export Trade

To take now the third main head of B.S.I. work, a primary need in drawing up British standards is again to ensure that the needs of export are fully taken into account. Over a wide field—such as the electrical industry, as Mr. Buist has shown—the existence of a British Standard is in itself a major selling point, but clearly the choice of what *is* to be the standard must meet not only the requirements of basic home production but also those of export trade—including compliance with local overseas regulations or insurers' requirements and the like, and the trend of international standardisation. As illustrating this point, the following are a few examples of standards where export considerations as such have vitally influenced the specification:

B.S. 1500 (Pressure vessels)—a standard which should help British chemical plant manufacturers to compete in world markets with the well-known American API standards.

B.S. 1744 (Tests for Agricultural Tractors). This standard is an important reinforcement in selling tractors overseas, where hitherto the only widely accepted test had been the "Nebraska" test of the U.S.A.

B.S. 697 (Rubber Gloves for Electrical Purposes). Here specifications for certain higher voltages have been retained, though regulations in the U.K. do not permit the use of gloves for such voltages: the additional specifications are entirely to meet the demands of export trade.

B.S. 1919 and B.S. 1978.—These specifications for hacksaw blades and bit braces were drawn up with clear recognition of the need to compete in export markets against recognised U.S. standards and ranges.

A standard strictly confined to the export trade is B.S. 1596 (Fibre Board Drums for export). This specification is an important element in securing a clean bill of lading for goods, cheaper insurance and more economic transport generally.

In the same context, it is useful to record that the British Standard Packaging Code embodies in a form suitable for practical application by industry all the great and very costly store of experience built up during the last War in the safe shipment of materials, machines and goods to all parts of the world. The Code provides sound guidance, enabling the exporter to package his product economically and to be

reasonably sure that it will arrive at its destination in a fit condition for use.

Conclusion

To sum up on B.S.I's three international assignments, it is clear that we are confronted with two current and parallel lines of development: at almost every level active collaboration between nations is expanding; in many countries industrial standards are gaining acceptance as a means to productive efficiency and competitive power. Surely it is inevitable that, so long as the climate of world relationships permits any intercourse at all, then these two parallel lines must tend to converge. To deny or oppose this trend is to retreat into defenceless isolation.

No one will attempt to argue that such an attitude is often encountered in British industry. But if the United Kingdom's position in the world's markets, and in world technology is to be maintained and strengthened, then industry itself must be ever watchful of developments abroad; and each section of industry must be well acquainted with what is being done and what more might be done by and through the B.S.I. to see that this country's case is fully presented and its interests adequately protected.

The purpose of this Paper is to stimulate even more active interest among industrialists and commercial people generally in B.S.I's conduct of these affairs. And if that interest provokes sound and constructive criticism, so much the better.

As an immediate and practical step we are setting up a small Export Panel, composed of outstanding men in industry, to advise the B.S.I. on export problems and the impact upon them of standards work. This help and advice will be of great value, but the work needs the thinking and experience of industry as a whole and at many points.

I hope that this Paper will have given a broad indication of the present scope and some of the great possibilities of international standards work—and thence a cue to comment and participation which practical men of business will accept.

THE SEPTEMBER ISSUE OF THE JOURNAL

will contain the following Papers presented to the Production Conference:

SESSION I

The 1954 Sir Alfred Herbert Paper

"**Some Problems of Higher Technological Education**" by The Right Hon. The Earl of Halsbury, F.R.I.C., F.Inst.P., Managing Director, The National Research Development Corporation.

SESSION II

"**Productivity and National Resources**" by D. Graham Hutton, O.B.E., Economic Consultant to the British Productivity Council.

SESSION V

"**The Gas Turbine and the Production Engineer**" by W. A. Sales, O.B.E., Director of Aircraft Production Development, Ministry of Supply.

SESSION XI

"**It All Depends on Management**" by F. C. Hooper, B.Sc., Vice-Chairman, British Institute of Management; Managing Director, Schweppes, Ltd.

HUMAN FACTORS IN TECHNOLOGICAL CHANGE

by BERYL FOYLE
(First Speaker)

Miss Foyle is Joint Managing Director of Boxfoldia, Limited, and Chairman of the Works Council. She is also Vice-Chairman of the Charles Henry Foyle Trust, and a member of the Joint D.S.I.R./M.R.C. Committee on Human Relations.

From 1952/54 she was Chairman of Group 2 of the Management Research Groups.

Miss Foyle is a member of the General and Executive Councils of the British Association for Commercial and Industrial Education; a member of Council of the Industrial Welfare Society; a Life Governor of Birmingham University and a member of Birmingham Education Committee; Chairman of the Printing School Advisory Committee and a member of the Joint Industrial Council of the Printing Industry, Birmingham.

Miss Foyle

WHAT is technological change? Any change in process, method or material. The change may be a major one, involving laying down of complete new plant over a wide area, such as production of steel in a continuous strip mill in place of an old method; it may be the introduction of different material which " eases " production at some stage, reduces waste and results in a better article; or it may be apparently minor changes in method of work, flow of production or operation of machine.

Technological change is frequently taking place in most firms; certainly in those of medium size and upwards. Every change of machine or equipment which is introduced, because there will be slight changes in operation, will arouse in someone (not necessarily the staff most directly concerned) some resistance. If industry is to develop more efficient methods—is to use its improved appliances efficiently—the emotions that create resistance must be overcome or avoided.

Enterprises *must* be continually changing and improving. Managements are driven to it by competition, which imposes the need to be efficient and continually to become more so. Even if there was no competition in this country, change and improvement would still be imposed by competition in world markets. There is no way in which we can contract out of progress if we want any of the benefits progress can give us.

It is generally believed that from time immemorial man has resisted change. It has always been the province of a comparatively small group of explorers (whether of the earth's surface, of the mind, or of new techniques) to innovate; and without this continuing small body of people in the community, we might still be living in mud huts.

To-day, with vast new territories of production techniques opening before us, the question of how to ensure that technological change can take place, as new techniques become available, is of paramount importance—for the country and for industry, as well as for the individual. Few people engaged in operating a particular machine devise a better machine to replace it. Usually it is some other person, looking at the job from outside, who invents a new process or a new piece of equipment.

To those who see the development of new techniques of production as beneficial, producing more, so that we may consume more, the resistance of a considerable body of labour is exasperating and often

incomprehensible. Industrial history is punctuated by industrial strife, usually between management and labour. This is often the result of management's efforts to become more efficient, and resistance on the part of labour to the changes involved. We look back on the development of Trades Unions, to deportations, strikes, machine wrecking, refusal to operate new equipment. Between the earliest resistances to technological change and the more recent ones, there lie years of struggle against change ; sometimes breaking into open conflict, but surely more often passive and not always recognised. But I am convinced that this resistance can and must be dealt with by management in a spirit of understanding, sympathy and honesty. To-day we would be less likely to encounter the machine wreckers, or even widespread strikes ; yet the weapons of resistance can be more subtle—restriction of output, negotiations for a larger labour force than the machinery demands, or for financial rewards far in advance of the value of the skill required and, perhaps, completely absorbing any saving in production costs the new equipment should have shown. Any one of these, although we are more likely to meet them in combination, inhibits progress, reduces our competitive power in world markets and bars us from the plenty—and the theme of this Conference is " Production for Plenty "—towards which we should be travelling.

Answering the Questions

I believe that to give an analysis of the problem is more important, certainly for discussion here, than to attempt a series of possible solutions. The fuller and clearer the analysis we can make, the closer we will be to solving the problem. Often we rush to apply a solution before we have correctly diagnosed the case. It is helpful in diagnosing to try to answer the questions that demand a direct and unequivocal answer ; and they are the questions :—

Who ?
What ?
When ?
Why ?
How ?

In other words,

Who are the people who innovate ? Who are the people who resist ?
When do we meet resistance ?
What is that resistance ? What form does it take ?
Why do people resist ?
How do we deal with the problem ? How avoid or overcome resistance ?

The innovators are, in the main, the engineers, scientists, technicians, management ; but all kinds of people have ideas in great or small ways, and a machine operator sometimes takes us a little way on the road to higher production by some good suggestion or improved technique, sometimes on his own job, sometimes on that of someone else. Chiefly, however, the major developments come from scientists and engineers, who can revolutionise a process. But before any development is even made available to industry it has to be " backed " by management ; first, in the undertaking where the equipment will be built ; secondly, in the firm where it will be used to produce. Sometimes there may be need of a third body of support—the ultimate consumer, who may be asked to buy a commodity unfamiliar in character or appearance. He may be asked to accept a revolutionary change in his mode of living or working, whether it be in the kind of house or flat he lives in, or the substitution of micro-film storage for filing cabinets.

Three Sources of Resistance

We have, therefore, three possible sources of resistance, for I would remind you that managements are not always godlike bodies with infallible judgment, but are composed of men and women with most of the usual failings of men and women.

The building and marketing of a new machine may present many difficulties and problems to its manufacturer. It may mean the complete reorganisation and planning of his factory and retraining of operators and of salesmen. There may also be difficulties of patents, problems of design details to solve, and the firm may well say : " Let our competitors do the donkey-work of development—we will come in when we see if it goes ! If no one else thinks of the idea, well, we're no worse off, we have a satisfactory market for our present type of machine. Why should we face dislocation, possible loss in the early stages, and then —if we make a success—other people copy, and competitively, we're back where we were ! "

If that resistance is overcome, we go on to the second group, the customers and users of the new equipment. Once it is on the market, possible users will investigate. If it shows an obvious advantage in his production—that means in reduced costs—then the customer will be interested. But it may still offer to him the same sort of questions that it offered the firm that developed it—reorganisation of production, retraining of workers, negotiations with Unions and all the possibilities of trouble and restrictions that can arise. Unless the gains are quite substantial, this second management may well say : " We'll have none of it, let us wait until there is an even better machine on the market—one so perfect it will be *worth* making sacrifices for in other directions ! "

And so we pass to the third possible resistor—the ultimate consumer. The new equipment may involve some slight change—most likely in appearance—in the product. Across the Atlantic, where constant changes take place, possibly partly as a result of production changes—and, of course, of standardisation—such changes would have not the slightest effect on the sale of the product so long as it was still advertised. British buyers are more conservative, and have to be reassured that the product they have always bought will be the same product, even though its appearance may be slightly different. But a sufficient inducement in the way of reduction in price, plus the clear assurance as to quality, is usually sufficient to overcome this aspect of resistance; and I think we need not refer to it again.

Overcoming Resistance

In dealing with the question " Who innovates ? ", we have as well begun to deal with " Who resists ? ",

because wherever one is looking for active support one has also the risk of active opposition.

Perhaps this helps me to make another point here. When we consider overcoming resistance on the part of operatives to technological change, there is a tendency to assume that it is to be converted into "passive acceptance". Obviously passive acceptance may be preferred to active opposition; but active support and enthusiasm for the change would be better still, and that, in my opinion, is what we should aim for. Our aim should be, surely, that every firm, every productive unit, should be an enthusiastic team —they should all be bubbling over with interest, enthusiasm, with the sheer fun of a new process. It is a regrettable reflection that one knows comparatively few firms where this would be case.

The *fourth* group of resistors is, of course, the core of the problem. This group is the one below top management level: those who are involved in the production of goods and in connection with whose work the technological change has to be applied: the departmental heads, the first-line supervisors and operatives, both men and women. When all other resistances have been overcome, and these usually will be overcome in a comparatively short time and usually with reason, this group can be the most difficult, the most intransigent and indeed, it has most reason on its side.

The Fear of Unemployment

What then are the considerations that engender this resistance to technological change? Fairly obviously the first that springs to mind is fear of unemployment, either for oneself or one's fellow workers. Technological change, and we are talking in this context of technological change that either produces more goods or produces the same goods with less labour, is a very real hazard to people employed in industry.

What in fact are the resistors resisting? Are they really resisting technological change, or are they resisting changes in their mode of living (financial, working hours, cleanliness); changes in their climate of work; change of employer; changes in their working group, the number or constitution of the team? Whilst there are few people who do not resist technological change, I believe it is also true that there are very few people who resist technological change because it *is* technological change.

My conjecture is that the majority like a change—changes in their environment. That is, they like slight differences in conditions of work (the Hawthorne experiments gave very good examples of this), changes in tools and equipment used—they like the idea of progress for themselves. The majority of people who are resisting what, to the rational scientist, engineer or businessman, are obvious and undeniable improvements, are not averse to improvements; but they are very much averse to reorientating themselves to a changed, and therefore new, situation. And there is widespread resistance because the ramifications of a change go far beyond the job in which the direct change takes place. You can almost hear the remark of the workman saying grumpily: "I don't mind working a new machine, but I know it won't stop there." Of course it does not, and cannot, stop there.

The effect of even the most minor change in methods of, or appliances for, production, produces widespread effects; and these are the changes that disturb the working group. This, perhaps even more than the financial aspect, is where the group becomes the unit which has to be reckoned with.

I have experience—as probably most of you have —where, not as a result of technological change, but purely as a result of a promotion or progressive policy, teams have refused to be broken up once they have grown accustomed to working together. Even the replacement of a weak member of the team by a better one can be resented by a group who feel strongly as a group; and they will stand by even the weaker member *providing* the rest are satisfied that the weak member is doing the best he or she can.

Social Security

This, of course, is "social security" in the literal (and best!) meaning of the term—"we are members one of another"—and the real expression of charity (= love) "which endureth all things" in the group. To me a short-term profitability outlook which leads management to "prune" the weak member is open to immediate ethical question. Also, I note that two factors enter:—

(a) A group which has become a "team" (knowing each other's ways) is more efficient, and also gives its members greater comradeship-satisfactions. (Hence resistance to loss-by-promotion.)

(b) The weaker member stands to lose if dismissed from the team (hence the docker-gangs who "carry" the old man as a member, even though he does little work).

Our next question is, "When do people resist?"

In fact, although it is not generally recognised, the fear of unemployment afflicts every group, including managements and owners of businesses. To the operative to-day the danger is a very real one and, apparently, a very obvious one. Memories of the between-war years are still very much alive and they condition reactions to changes in industry.

Other aspects of security may also influence individual or group reaction. Loss of skill, or allowing a skill to fall into disuse, is another aspect of security. (Perhaps one of the outstanding examples of this is the shorthand-typist who resists the use of dictating machines because her shorthand will fall into disuse). The loss may be of the feeling of superiority that a skill is possessed that others have not; the fear that in the event of a change of employer the lost skill will be the one that is demanded.

Undoubtedly any move forward by one firm pulls all others gradually in its train. They must all switch to the more efficient method; but the time lag in this country, due undoubtedly to these resistances of which we are talking, may be anything up to 50 years —depending upon the degree of change. So the skill that is relinquished when a new process is developed for the same purpose may, in fact, be wanted again if the operative changes his employer.

Again, the new skill involved in a change in

process may appear to be a less " skilful " skill than that required for the old. Most people take considerable pride in their skill, directors and managers in their judgment; in their skill in buying in the cheapest market and selling in the dearest ; in their skill in getting people to do the things they want. Supervisors take pride in their skill in putting their instructions into a form which is quickly and clearly understood by those who have to follow them ; the operative, in his skill, whether of a technical or a manual nature, in carrying out the actual operation.

The relinquishing of one skill to take up another is sure to be fraught with doubt, hesitation and a considerable measure of criticism of the need. To the individual concerned there is, firstly, the risk of failure ; and secondly, the hard work and time consumed in having to master a new skill. In addition, and it is undoubtedly true, the older the individual is when he has to change to a new type of work or a new type of skill, the more difficult it is and the longer it takes him to master it. The conviction that the new skill to be mastered both *can* be mastered, and will justify the same social status as the old, will obviously be a factor in the willingness and speed with which an operative will both change to and learn a new type of work.

Reasons for Resistance

So we come to " Why ? ", which is a fairly natural development of " When ? ". The simple answer could so easily be given, that people resist change because they do not recognise that the change will benefit them as well as others. But this is too simple. The " Why ? " certainly hinges upon misunderstanding ; but for us this analysis of " Why ? " and the degree of our understanding of it will determine the speed and effectiveness of our solution to any resistance. I have already suggested that people are not just against technological change. They are antagonistic to all the other changes that technological change brings in its train. They fear changes in their social status, both inside and outside the factory ; they fear loss of skill, the loss of material security, the changes in the work-group and the consequent loss of social security.

The fear of changing skill applies with still greater force to those who may, as a result of technological innovation, be rendered surplus to a particular type of production and therefore have to retrain for other work.

Following close upon the fear of unemployment is the fear that a new type of employment may be

(a) harder ;
(b) less well paid ;
(c) of a lower social status ;
(d) with a group less compatible to the individual that his present group of workmates ;
(e) with a management or a supervisor that is not liked.

There is scarcely need to labour this point. We must all know pretty well how an individual person will feel in these circumstances. Looking for new employment in such a case, few can go out with that sense of zeal and adventure that should normally be the concomitant of the pursuit of a new job.

It is this difficulty of taking new jobs and acquiring new skill, combined with the between-war difficulty of finding a job at all, that has inspired much of the defensive negotiations and agreements that have become current in recent years to render ineffectual the aids to improved production. It would be interesting to know whether there is any industry to-day that could claim freedom from some form of restriction of output.

It has been recognised that the simplest way of dealing with threatened redundancy and unemployment is to impose the unemployment on the job itself. We negotiate with representatives of labour and agree that the same number of men, or the same number of operatives of the same class, should continue to be employed to turn out a given quantity of goods. Mythical machines tended by material men and paid, in spite of the tax collector, with material money that will buy material goods, is to-day's solution to our problem of production.

To my mind, it is a connivance at fraud to be a party to this type of agreement ; and it is a policy of despair that any sane body of men and women, whether they represent management or labour, should engage in such agreements. It is, of course, the hardest work in the world to do nothing : to permit oneself to be idle when there is work to be done ; and the existence of agreements of this type is the measure of the fear that individuals have of the alternative, the risk of a change, the dislike of taking up other work. This aspect of our problem is to my mind the most serious and the most difficult to overcome. Indeed and unfortunately, it has the stamp of a certain type of rationalism; managements lend themselves to this type of agreement because, so long as all other firms in the industry have to work under the same agreements, they feel that competitively nothing is being lost.

A Serious Loss

The loss, to my mind, is the immediate one of the debasement of the individual who is involved in production under those conditions ; and also the loss of the vital force of productive effort within the organisation in which it occurs, because it is known that slackening-off in one section of an organisation is followed by slackening-off all round. This latter is the serious loss, having repercussions far beyond the immediate job or organisation in which it occurs. It is a continuing loss ; because once this procedure is recognised and ratified, it is very difficult to restore those who have been concerned in it to full productive effort. It has the effect of wearing down management's enthusiasm for change, for improving techniques, for increased or improved output. If there can be no benefit, except to lighten the workload of those favoured few working on that operation, why should technologists, engineers, managers, and all the other specialists attached to industry, develop better methods ? What is not always recognised in industry and certainly not among operatives, is that managements, too, need incentives to encourage them to go on. The refusal to accept changes that result in better and more production is a disincentive to management, a discouragement for which, ultimately,

the whole of industry pays. Following this there is the immediate loss to the nation of the production of actual goods. Ultimately, the penalty for those who engage in these agreements, both management and labour, is first the loss of markets abroad—where such agreements do not always exist—followed by the development of other processes which may replace theirs altogether.

Preventing Resistance

How are those of us who are responsible for industry to deal with resistance to technological change or (for preference) to prevent it developing? Fairly obviously, the first defence is to prevent the resistance arising at all. That is very much better than having to deal with it when it does arise. The first thing I would suggest to you here is that if a firm has a long tradition and history of being in the forefront technologically, it is likely to have less trouble as development proceeds, whatever its philosophy or policy or history has been in other ways.

There is a certain advantage in consistency; and if a firm has already a tradition, not merely of taking advantage of new developments, but also of so organising itself that the adoption of new ideas and improved methods of production does not create redundancy, if the firm has always been able in the past to absorb any surplus labour by expansion, additional processes or any other means, then it is likely to have least trouble.

If, however, it has a good record in this direction and yet then has to face an unfortunate situation where the new development will cause redundancy that cannot be absorbed, then it will face more trouble and more bitterness than the firm that never has attempted to absorb redundant labour.

Trend of Change

The trend of change as between one manufacturing unit and another in the same industry varies considerably; from the firm which makes changes as the possibility of change arises, so that it is evolving from year to year, to the firm where no changes at all take place, or so few that they are not discernible. In the former type of firm, the installation of a completely new piece of equipment, one that requires changes in techniques and changes in type and numbers of personnel, will have a lesser impact on the organisation as a whole than in the latter type of firm. When, in the latter undertaking, it becomes so abundantly clear that competitors are far and away more efficient that the firm at last reorganises itself, buys and installs new equipment, there is created a " revolution " within the firm that may well break it.

Tradition and history play a very big part in the acceptance or non-acceptance of technological change, although I am not entirely convinced that communication is necessarily best developed in the best-organised production units. In fact, it may well be the reverse. There is some danger, in well-organised undertakings, that, unless the channel of communications is clear, distinct, specified and used, information will be withheld or suppressed; either through discretion, the fear of divulging something that should not be made available, or through the desire on the part of one or more individuals to hold information which they feel gives them an advantageous position over other people.

In less well-organised undertakings information often seeps down through all departments and individuals; so that the element of surprise is usually eliminated.

At every stage, I believe, in the development of some new method of production—and indeed I would probably extend this over a very wide range of industrial development and industrial planning—there should be full communication, co-ordination and co-operation involving every individual who is likely to be in any way involved in the change. The extent to which this communication is to be formal, I do not think I can deal with at length here. It is sufficient to say that there should be a combination of formal and informal. In other words, the " formal " to give an authoritative air to information and to ensure that people " take notice "; the " informal ", because that provides an opportunity for more information than could be given in an official document; for individual and unofficial comments and criticisms; for developing the sense of community amongst operatives; for picking out individuals for " confidences ", and as well, because the informal method usually enables the information to penetrate further afield than does the formal.

Time for Adjustment

There is, I believe, a period of time which must elapse before a change becomes acceptable. I have been aware of this for some considerable time.

Even in those firms that have a record of progressive development, you will meet the comments of " It won't work "; " I should not like that "; " It will mean so and so ". But if time can be given for the information to seep through the organisation and into the minds of those who will be concerned, the time will come when the change will become acceptable and even welcome.

The greatest danger and menace in this connection, I think, may well be the innovator himself. There are those —and I think it may perhaps be a characteristic of inventors (why should it not be if they have a pride in their " skill " comparable with the pride others feel in skill?) that having invented or developed a new method, they like to display it in one blinding flash of inspiration. They are doubly discouraged and offended when, instead of receiving the plaudits of the crowd, they are challenged and vilified. To a lesser degree this is true also of the director who, having satisfied himself and just a small group of his technicians that a certain piece of equipment will improve production methods, buys the equipment as a " pleasant surprise " for the rest of the staff; and again is shattered and indignant because it is not received with acclamation.

If such a person would only take a leaf out of the book of the groups of operatives, men and women, who aver that the only way to get a suggestion accepted is to put it into the mind of their chief so that he thinks he suggested it himself, then he might

achieve his object more quickly, more cheaply and with very much less effort.

The question seems to be whether the intention is to develop the business, to improve production techniques and to create a more profitable, more progressive, more competitive undertaking ; or whether what the person concerned wants is to be established as a brilliant innovator and developer. If this is his intention, then the individual concerned must recognise that there will be some danger that he will innovate himself " out of business ".

I believe that there is both time needed for ideas to germinate and, if we may continue the same simile, that there is a limit as well to the fertility of the ground. Innovations must not come too thick and fast for people to assimilate. People feel that they are losing their grasp and do not know what is going on all over the factory.

The time that it may take for any particular change to become acceptable will be determined partly by the preparation that has gone before in the building up of tradition and history ; in other words, whether the individuals who make up the organisation are generally receptive and have generally found change to be beneficial to them, both as individuals and as a social group, as well as to the undertaking ; and, of course, the magnitude of the change. A small change will go through quite quickly. In fact, probably no time at all is needed for acceptance if it is put forward clearly and comprehensibly. Another and more major change may easily take 12 months ; and whilst I am not in any way justifying timidity and indecision, what I would advocate is that members of the organisation should have the earliest possible notice of any change likely to take place. Usually, possible changes are projected by the management well ahead, but only reach operatives shortly before the change is to take place.

Multiplicity of Changes

On the multiplicity of changes, I would add that there is a chain reaction in changes that should not be overlooked. A technological change taking place in a remote part of a factory and without obvious connection with some departments may, in fact, affect those departments ; not vitally, not even very materially ; but, in the same way as a slight change in appearance or composition may affect a customer's reaction, so reactions throughout an organisation are affected by changed processes. If the number of changes taking place at any one time exceeds what an operative can grasp—if it is beyond his imagination—then he tends to take refuge in antagonism.

In developing active acceptance of and participation in technological change, we should recognise not only the value of disseminating information at an early stage, but recognise also the value of obtaining advice, ideas, suggestions on the project ; and by asking advice get people used to the idea of the particular change under consideration. If a manager believes that a change, whether it be the development of a new technique or the buying of new equipment, will give greater production and he calls members of the undertaking into consultation, he is likely to find less opposition than if the equipment is ordered and the first notification the operative gets is when it arrives ; and moreover he is likely to get some useful ideas. The chances are that, if it is going to be met, management meets opposition at the beginning and that gradually people get used to the idea of the change. This getting used to the idea is hastened by the pride that an individual undoubtedly feels at being consulted. He feels that he is the recipient of knowledge and indeed of confidence.

Learning New Skills

On the learning of new skills it is not generally recognised that the " skill " required to operate an " automatic " machine is often greater, not less, than that required for the less refined type of equipment. The newer machine is usually more sensitive ; the chances of breakdown, if used wrongly, more probable; the variations in production are more pronounced, reflecting more clearly the degree of skill possessed by the operator. If a breakdown occurs, the cost of repair will be much higher and the loss of production whilst repairs are carried out more serious.

The skill demanded by new equipment and the importance and value of that skill to the undertaking as a whole should be made abundantly clear to those required to develop and use it.

In our efforts to increase and improve production, we should not blind ourselves to the fact that we are making our undertakings more profitable. Undoubtedly, also, we are benefiting mankind ; we are making more goods available and we are enabling individual people to earn more in order to buy those goods. In any changes that are made which will increase production, it must be made clear to the operative exactly what he is going to get out of it. There is some validity in the question that an operative asks : " Why should I bother to learn a new skill if I am not paid any more for it ? "; if, in fact, all we do when we put in new equipment is either to pay exactly the same day-rate or to reduce the piecework rate to such a level that the individual earns only the same amount as before the change. It seems to me to be as reprehensible as the attitude of the operative who claims that the full benefit of the better equipment should be reaped by himself and his fellows.

The economics of the project should be explained to those who will be concerned. If a firm invests additional capital, and usually it is considerably more capital, in a new machine which with the same labour will produce two or three times as much, then it is fairly clear that management will only be justified in installing such machinery if the result is the increased profitability of the undertaking. In the same way, the individual operative will only be justified in taking an interest, adjusting his skill and his outlook and learning to use the machine to produce the maximum quantity of goods, if it is also profitable to him.

It would probably not be unjust to managements to-day to say that insufficient care generally is taken to ensure that operatives understand the financial considerations that determine the machinery we buy, or indeed the specialists we employ. And it is absolutely essential that only the truth will serve in this connection, and it must be possible for operatives within reason to check the figures that are placed before them.

To sum up, there is no natural resistance to change ; only an induced resistance based on bitter experience, the failure of consultation and communication and the failure to ensure that individuals understand the benefits that will accrue to themselves through the development of improved techniques. This has developed resistance in depth ; restrictive practices. both on the part of labour and of management, Managements have to correct the impression left by past history ; they must build up a reputation for a progressive policy of development and of maintaining employment. They have to build an enthusiastic team by consultation and by ensuring that the benefits of change accrue, and are understood to accrue, to all those who work.

A TALE OF THREE EXHIBITIONS (*concluded from page 436*)

between, say, the machine tool and the gauge and tool makers. I found this difficulty in U.S.A. also, and many there shared my views that something must be done to modernise this outlook and to show in a more comprehensive manner the machines and the great array of equipment that can be used in conjunction with those machines.

The Production Exhibition

And now for the third and most recent Exhibition, at Olympia. The Institution was very glad to give its sponsorship to Andry Montgomery, Ltd., who had proved themselves successful over many years in organising the Building Exhibition, and who had the public spirit to risk their own money on a new form of Exhibition. This partnership turned out to be a very happy one and speaking on behalf of our Institution at the final Conference Session, I was able to say that the organisers had achieved considerable financial success, and that both they and we were entitled to claim that almost all our objectives had been attained.

It is not necessary for me here to define once again the objectives we had in mind. Many of you visited the Exhibition and both read and saw our purpose; in fact, nearly 40,000 people visited Olympia and of that number almost 7,000 attended one or more of the Conference Sessions. On figures, alone, therefore, we feel justified in saying that something real was attempted and achieved. We have had the added satisfaction of receiving many letters of commendation, some from junior members of the Institution and many from those high up in their profession. We are grateful for the interest and practical help given by so many people.

It is perhaps too early to say when and in what form the next Exhibition shall take place. Many of those exhibiting told me that they could now do an even better job based upon their experience this time. We are convinced that a new form of Exhibition of this nature is needed and that there should be, at regular intervals, at least one national platform where the British ways and means of achieving 'Production for Plenty' are shown to the world, as distinct from the variety of end products which have their own forms of display.

Perhaps a future Exhibition of this nature may be able to show, in a more comprehensive manner than is possible at specialist exhibitions, the examples of integrated production techniques and equipment mentioned earlier. It should not be too difficult to expand the techniques used by a few companies already and to demonstrate a number of complete production lines. One can envisage examples where we have a variety of machines on display, coupled with the best form of material handling equipment, linked up to the best quality and quantity control equipment, recorded and checked by the best form of instrumentation. Such comprehensive examples as these, which must be an ever greater feature of industry itself, are likely to seize the imagination of our young production men to a very great degree, and will illustrate by practical means that however important it is to design and exhibit a number of separate well-designed machines and pieces of equipment, it is equally important to see that all these are built into a complete working unit, the achievement of which springs from the parallel and concerted activity of an ever wider group of technologists and industries.

This, in brief terms, is our future Exhibition policy; it is, when you think about it, likely to be the major aim of production engineers themselves.

Production Exhibition and Conference

The First Production Exhibition and Conference, which took place at Olympia from 7th/14th July, was so successful that plans are already being considered to hold the Second Production Exhibition and Conference in 1956.

The Exhibition, which was sponsored by the Institution of Production Engineers and organised by Andry Montgomery, Ltd., attracted many thousands of visitors, and almost 7,000 people attended the Conference Sessions arranged by the Institution.

The opening ceremony was to have been performed by the President of the Board of Trade, Mr. Peter Thorneycroft, M.P., but as he was detained in America on trade talks, Sir Walter Monckton, K.C.M.G., K.C.V.O., M.C., Q.C., Minister of Labour and National Service, kindly consented to take his place.

On the day after the opening, the Exhibition was honoured by an informal visit from H.R.H. The Duke of Edinburgh, Patron of the Exhibition and Conference. His Royal Highness spent over an hour touring the exhibits with the President of the Institution, Sir Walter Puckey, and Mrs. Montgomery, Managing Director of Andry Montgomery, Ltd. Among other prominent visitors during the week were Sir David Eccles, Minister of Works; Mr. Heathcoat Amery, Minister of State; Mr. Peter Thorneycroft, M.P. (on his return from America); and the Parliamentary Secretaries to the Ministries of Supply, Labour, and Education, and the Board of Trade.

Sir Walter Puckey, summing up at the close of the final Conference Session, expressed the great appreciation of the sponsors and organisers for the wholehearted support they had received from national organisations, including the Department of Scientific and Industrial Research, the British Standards Institution, the Trades Union Congress, the British Productivity Council, and the British Institute of

His Royal Highness The Duke of Edinburgh spent over an hour at the Production Exhibition and asked many questions regarding the exhibits. In this photograph, taken in the Production Engineering Research Association's mobile demonstration unit, Dr. D. F. Galloway, M.I.Prod.E., the Association's Director of Research, explains an interesting point. Also in the photograph is the President of the Institution, Sir Walter Puckey, who escorted His Royal Highness round the Exhibition.

Management, and from all the exhibitors who had taken space, particularly those associated with the Institution. It was almost entirely due to such bodies and individuals that the enterprise had been carried through to such a gratifying conclusion.

A full report of the Proceedings, including the Papers and ensuing discussions, will be available towards the end of September as a separate publication.

A. J. Mansell Fund

The Institution is pleased to report that the total amount collected for the A. J. Mansell Fund, including the major part collected under the auspices of the Institute of Industrial Supervisors, now stands at approximately £1,600.

A special appeal organised by the President of the Birmingham Section, Mr. B. G. L. Jackman, has closed at £404. 6s., and Mr. Jackman wishes to express appreciation once more to all those members in all parts of the country who contributed so generously.

A.S.T.E. Exposition Papers

Copies of the Papers presented to the A.S.T.E. Exposition held in Philadelphia, Pa., in April last are available on loan to members from the Hazleton Memorial Library, as follows:

Ref. No.	Title and Author
22T1	" Rolled Extrusion of Thin-Walled Parts " by W. N. Parker, Development Engineer, Tube Division, Radio Corporation of America.
22T2	" Joining of Thin-Walled Parts by Rubber-Clamping " by Frank R. Simpson, Director of Research and Development, The Kiljian Corporation.
22T3	" Surface Finish Control with Blast Cleaning " by A. P. Neumann, Chief Engineer and Consultant, Vapor Blast Manufacturing Co.
22T4	" Ultrasonic Techniques in Industrial Cleaning " by Dr. W. McCracken, Director of Research, Detrex Corporation.
22T5	"A Program for Developing Tool Engineers into Manufacturing Executives " by R. F. Pearse, E. I. Worthington, and J. J. Flaherty, Worthington Associations, Inc.
22T6	" Scanlon Plan Employee Relations at Different Production Levels " by E. M. Dowd, Executive Vice-President, The Lapointe Machine Tool Co.
22T7	" Some Recent Developments in the Analysis of Chip Formation " by Bernard W. Shaffer, Associate Professor, Department of Mechanical Engineering, New York University.
22T9	" Magnetic Holding of Ferrous and Non-Ferrous Materials " by Frank Suchanek, Field Engineer, Sunstrand Magnetic Products Co.
22T10	" Jig Design for Multiple Automatic Operations " by F. G. Zagar, General Manager, Zagar Tool, Inc.
22T11	" Process Applications for Dual-Frequency Induction Heating " by R. S. Segworth, Director of Research, General Engineering Co., Ltd.
22T12	" High Production Tooling for Induction Heating " by C. E. Glick, Production Engineering Manager, and P. N. Sorenson, Chief Test Engineer, Tocco Division, The Ohio Crankshaft Co.
22T13	" How to Plan a Transfer Machine " by D. E. Hawkinson, Vice-President, Machine Tool Sales, Greenlee Bros. & Co.
22T14	" Creativity in Mechanical Design " by H. A. Oldenkamp, Director of Engineering, General Engineering Labs., and L. Strauss, Project Manager, American Machine & Foundry Co.
22T15	" Changing Trends in Mechanical Fasteners " by W. C. Stewart, Technical Adviser, Industrial Fasteners Institute.
22T16	" Fastening Techniques for Small Assemblies " by V. L. Bradford, Vice-President, Milford Rivet & Machine Co.
22T17	" The Possibilities for Castings in Airframe Design " by A. H. Petersen, Design Group Engineer, Lockheed Aircraft Corporation.
22T18	"Automation of Shell Molding " by L. J. Bishop, Vice-President and Director of Engineering Mechanical Handling Systems, Inc.
22T19	" Nucleonics Invades the Tool Engineering Field " by Lionel S. Goldring, Nuclear Chemist, Nuclear Development Associates, Inc.
22T20	" Tracer Controlled Pantographic Milling " by A. D. Gunderson, Assistant Chief Engineer-in-charge of Tooling, George Gorton Machine Company.
22T21	" New Arts in Jigless Boring " by C. B. DeVlieg, President, DeVlieg Machine Co.
22T24	" Post-Forming of Thermosetting Laminates " by St. John Bain, Engineer, The Formice Company.
22T25	" Design and Dimensional Control for Investment Castings " by R. L. Wood, President, Arwood Precision Casting Co.
22T27	" Manufacturing Applications for Coated Abrasive Belts " by E. E. Oathout, Product Engineer, Behr-Manning Corporation.
22T28	" Hydraulically Cammed Contour Grinding " by Alvin F. Alt, Chief Engineer, Planet Products Corporation.
22T29	" Flame Cutting with Electronic and Magnetic Tracers " by R. F. Helmkamp, Machine Cutting Specialist, Air Reduction Sales Co.
22T30	" Sub-Zero Chilling as an Industrial Process " by R. S. Jamison, Assistant to President, Sub-Zero Products Co.
22T31	" Ultrasonic Tools for Hard-to-Machine Materials " by J. P. Aloisio, Applications Engineer and N. Clark, Jr., Research Division, Raytheon Manufacturing Co.
22T32	" Hobbing Gears at High Speeds " by J. W. Rapp, Supdt. of Gear Manufacturing, Ohio Axle and Gear Division, Rockwell Spring and Axle Co.
22T33	" Billet Separation by the Shear-Fracture Method " by W. C. Tucker, Chief Engineer, Buffalo Forge Company.
22T34	" Successful Design of Steel Parts for Cold Extrusion " by D. I. Brown, Market Development Manager, Mullins Manufacturing Corporation.
22T35	"An Orderly Use Classification of Cutting Fluids " by R. G. Moyer, Group Engineer, The Pure Oil Company.

22T36 " What is Known Today About Machining Titanium " by G. T. Fraser, Sales Manager, Rem-Cru Titanium, Inc.

22T37 " Preparation and Tooling for Cold Pressure Welding " by W. A. Barnes, Vice-President, Engineering & Production Division, Utica Drop Forge & Tool Corporation.

22T38 " Visualising Plant Layout in Three Dimensions " by H. H. Dasey, President, Visual Plant Layouts, Inc.

22T40 " Optical Tooling for Fixture Construction " by R. E. Stegler, Engineer, Manufacturing & Research Development Section, Republic Aircraft Corporation.

22T41 " New Concepts of Gaging and Inspection " by W. I. Wilt, Assistant Manager, Gage Division, and H. Kiefaber, Gage Application Engineer, Sheffield Corporation.

22T42 " Product Designing for Powder Metal Parts " by George Stern, Vice-President and Technical Director, American Electro-Metal Corporation.

22T43 " Tooling for Powder Metallurgy " by J. F. Kuzmick, President and Powder Metallurgy Consultant, Welded Carbide Tool Co.

22T44 " Plastic Fixtures Have Wide Use " by Benjamin Sokol, Plastics Engineer, Republic Aviation Corporation.

22T45 " Plastic Dies Move into Regular Production Service " by George C. Adams, Staff Engineer, Rezolin, Inc.

22T46 " Plastic Auto Body Developments " by William A. Hermonat, Technical Representative, Naugatuck Chemical Division, U.S. Rubber Company.

22T47 " Welding and Brazing of High Temperature Materials " by F. H. Stevenson, Welding Engineer, Aerojet-General Corporation.

22T48 " Ferrous and Non-Ferrous Stud Welding " by R. C. Singleton, Industrial Sales Manager, Nelson Stud Welding Division, Gregory Industries, Inc.

22T49 " Principles of Stretch-Wrap Forming " by Kingsley Drone, Chief Engineer, Hufford Machine Works, Inc.

news of members

Mr. E. W. Beever, Associate Member, has been appointed Chief Industrial Engineer of Euclid (Great Britain), Ltd., Lanarkshire.

Mr. J. E. Beglan, Associate Member, has been appointed Works Manager, Converting Factories, of Thames Board Mills, Ltd.

Mr. E. G. Brisch, Member, has been elected a Fellow of the Royal Society of Arts. Mr. Brisch serves on the Standards Committee of the Institution, which he also represents on the Editorial Committee.

Mr. Clifford S. Chanter, Associate Member, has now taken up an appointment in the Development Department of the Wilkinson Sword Co., Ltd.

Mr. H. C. Cleaver, Associate Member, is now Assistant Lecturer, Grade B, at Brooklyn Farm Technical College, Birmingham, with responsibility for engineering subjects.

Mr. E. N. Farrar, Member, has recently been appointed Chief Plant Engineer of Davey Paxman & Co., Ltd. Mr. Farrar is Chairman of the Eastern Counties Section.

Mr. W. Gillespie, Member, has recently taken up an appointment as Principal of The College, Swindon. Mr. Gillespie is a corresponding member of the Institution's Papers Committee.

Mr. H. A. Gordon, Associate, has now left Standard Telephones & Cables, Ltd., and has accepted the appointment of General Manager with Stronis, Ltd.

Mr. L. W. Hampton, Associate Member, has taken up an appointment as Production Engineer with Aldford & Alder (Engineers), Ltd.

Mr. A. L. Hipwell, Associate Member, is now Managing Director of Alfred Herbert (Australia), Pty., Ltd., Australia.

Mr. B. G. L. Jackman, Member, has been appointed General Manager of Minimax, Ltd., Middlesex. Mr. Jackman, who is Chairman of the Birmingham Section, serves on Council and on the Finance and General Purposes Committee of the Institution, and is a corresponding member of the Papers Committee.

Mr. D. B. Jephcott, Associate Member, has been appointed Head of the Engineering Department at the College of Further Education, Loughborough.

Mr. J. Kemsey-Bourne, Associate Member, has now left Stockport College, and has taken up an appointment as Chief Time Study Engineer at the Bank Works of Platts (Barton), Ltd.

Mr. Ian Marriott, Member, has been appointed to the Board of Wellworthy, Ltd., Lymington. On leaving the Army at the end of the War, with the rank of Lieutenant-Colonel, Mr. Marriott was appointed Group Commercial Director of the British Electrical Engineering Co., Loughborough, and later became Managing Director of W. G. Bagnell, Ltd., Stafford. He succeeded the late Mr. Harry Parsons, J.P., as Managing Director of Parsons Engineering Co., Ltd., Southampton, and relinquished this appointment to join Wellworthy, Ltd., last year.

Mr. Marriott

Mr. G. R. Marsh, Member, who has been a Director of Wickman, Ltd., for 14 years, has now been appointed Managing Director.

Mr. W. J. Marshall, Member, has recently been appointed Director and General Manager of Onneley Implements, Ltd. Mr. Marshall was Honorary Secretary of the Wolverhampton Section from 1947 until last year.

Mr. D. H. Mason, Member, formerly with the Ministry of Supply, has been appointed Works Controller of the B.R.D. Company, Aldridge, Staffs., one of the G.K.N. & Garrington group of companies. As a member of the London Section, Mr. Mason took an active part in Institution affairs, doing much work as a Section Committee member, and as a serving member of the Hazleton Memorial Library Committee.

Mr. R. G. Masters, Associate Member, has joined the Aeronautical Inspection Directorate of the Ministry of Supply.

Mr. A. T. Morrison, Associate Member, has now taken up a position in the Design Offices of Vickers-Armstrongs, Ltd., Aircraft Division, Weybridge.

Mr. A. W. Page, M.B.E., T.D., Member, has been appointed London Manager of the Igranic Electric Co., Ltd. Mr. Page, who represented the Igranic Company at Newcastle-on-Tyne prior to the Second World War, served with the Tyne Electrical Engineers, R.E., and saw service in India, the Middle East, Italy and Germany attaining the rank of Lieutenant-Colonel. His post-War service with Igranic has been as Production Engineer and, latterly, as Deputy London Manager.

Mr. Page

Mr. A. N. I. Pratt, Associate, has relinquished his position with Teddington Controls, Ltd., and is rejoining W. Edwards & Co., as Supply Manager.

Mr. H. Gilbert Ramsell, Member, has been appointed General Manager of the British Lock and Hardware Division and the British Materials Handling Division of the Yale and Towne Manufacturing Company, Willenhall, Staffs. Mr. Ramsell has been General Works Manager for the past 25 years.

Mr. F. H. Rolt, O.B.E., Member, has been awarded the degree of D.Sc. by the University of London for his various publications on Metrology. Until his recent retirement, Mr. Rolt was Superintendent of the Metrology Division at the National Physical Laboratory, and presented the First Sir Alfred Herbert Paper to the Institution in 1952.

Mr. James W. Rose, Associate Member, has recently been promoted to Chief Planning Engineer, D. Napier & Son, Ltd., and is responsible for Planning, Jig and Tool Design, and Ratefixing.

Mr. J. Tocher, Associate Member, has resigned his appointment as Technical Director at Warne Wright & Roland, and has now taken up a position with the Lockheed Hydraulic Brake Co., Ltd., as Deputy Divisional Manager of Borg and Beck.

Mr. A. Whiston, Member, has been appointed Sales Manager of Stuart Davis, Ltd., Coventry, after spending 12 months as their London representative.

Mr. P. R. Browse, Graduate, is now with the Ministry of Supply, R.O.F., Brightfield.

Mr. J. F. A. Bryen, Graduate, has been appointed Kit Marshalling Supervisor with A.E.C., Ltd. He was formerly Group Units Supervisor with the same company.

Mr. B. Farmery, Graduate, has recently changed his position to that of Engineer-in-charge of No. 2 Shaft, Michael Colliery.

Mr. G. Harrison, Graduate, is now Manager, Boiler Department, with Steam & Mining Equipment (Pty.), Ltd.

Mr. W. A. Hendrie, Graduate, is now Assistant Production Manager of Isotope Developments, Ltd., Reading, having relinquished his position of Production Management Information Officer with the British Institute of Management.

Mr. S. Jovanovitch, Graduate, has recently taken up an appointment as Work Study Engineer with the Telegraph Construction and Maintenance Co., Ltd.

Mr. F. A. Mee, Graduate, has been appointed Lecturer in the Department of Mechanical Engineering at Coventry Technical College, where he was formerly Assistant, Grade B.

Mr. F. B. Pearce, Graduate, is now Technical Assistant, Grade II, H.Q. Base Workshop Group, R.E.M.E., Chilwell, Notts.

Mr. F. Tilston, Graduate, is now a Production Planning Engineer with A. V. Roe (Canada), Ltd., Ontario.

Mr. E. Perry, Graduate, is now Production Engineer with A. G. Hayek & Partners, Ltd., Stoke-on-Trent.

Mr. J. Rook, Graduate, has been appointed Chief Engineer with A. G. Wild & Co., Ltd., Sheffield.

Mr. J. Walker, Graduate, has now returned to the United States after three months' vacation in England, and is employed at the Ford Motor Co., Aircraft & Engine Division, as a Process Engineer.

Mr. E. Willcox, Graduate, has been appointed Works Manager of Ellis, Son & Paramore, Ltd., Sheffield.

Mr. J. L. C. Wright, Graduate, has joined the Sales Engineering Department of Keith Blackman, Ltd.

Future Institution Activities

The attention of members is specially drawn to the following important events:

Fifth Annual Summer School will be held at Ashorne Hill, Warwickshire, from 25th/29th August, 1954, on the theme: "Practical Training for Production." Full details and an application form were circulated with the July Journal.

The 1954 Sir Alfred Herbert Paper. The Right Hon. The Earl of Halsbury will repeat his Paper on "Some Problems of Higher Technological Education" at a Regional Meeting in Wolverhampton, on 9th September, 1954.

Institution Annual Dinner, 1954, will take place at the Dorchester Hotel, London, on Friday, 8th October. An application form for tickets appears in the Supplement to this month's Journal.

One-Day Conference on Materials Handling, organised by the Institution's Materials Handling Sub-Committee, will be held on 23rd October, 1954. Details and application form appear in this month's Supplement.

Third Aircraft Production Conference, organised by the Southern Section of the Institution, will be held in Southampton in January, 1955. Full particulars will be published later.

NEW BUILDING FUND APPEAL

Since the publication of the last list, donations have been received from the following subscribers. (The list was compiled for press on 22nd July, 1954.)

N. K. Adderley, A.M.I.Prod.E.
J. E. Adkins, Grad.I.Prod.E.
P. S. Agarwal, Stud.I.Prod.E.
B. J. Andrew, Grad.I.Prod.E.
R. J. Andrews, A.M.I.Prod.E.
Anderson Grice Co.
N. Asquith, Grad.I.Prod.E.
G. H. Aston, Grad.I.Prod.E.

A. Bailey, A.M.I.Prod.E.
J. A. Bailey, M.I.Prod.E.
R. Bailey, Grad.I.Prod.E.
H. J. Baker, A.M.I.Prod.E.
B. W. Ball, Stud.I.Prod.E.
M. E. Barton, Stud.I.Prod.E.
J. Bates, A.M.I.Prod.E.
E. H. Benbow, M.I.Prod.E.
J. T. E. Bennett, Grad.I.Prod.E.
G. A. Berger, A.M.I.Prod.E.
D. N. Bird, Stud.I.Prod.E.
E. H. Blanchard, A.M.I.Prod.E.
K. A. Blumenthal, Grad.I.Prod.E.
G. S. Boothroyd, A.M.I.Prod.E.
J. E. Boughton, Grad.I.Prod.E.
R. D. Bourne, Stud.I.Prod.E.
E. J. Bradley,A.M.I.Prod.E.
B. Brewster, Grad.I.Prod.E.
H. P. Browne, A.M.I.Prod.E.
J. E. Burnett, A.M.I.Prod.E.
A. N. P. Byford, A.M.I.Prod.E.

A. Cameron, A.M.I.Prod.E.
E. Carpenter, M.I.Prod.E.
E. S. Carter, A.M.I.Prod.E.
S. B. Chanda, Grad.I.Prod.E.
R. E. Charman, A.M.I.Prod.E.
G. Cheater, Stud.I.Prod.E.
L. A. Childs, A.M.I.Prod.E.
C. J. Clark, A.M.I.Prod.E.
E. N. Coates, Grad.I.Prod.E.
A. Cooper, Grad.I.Prod.E.
K. A. Cooper, Grad.I.Prod.E.
A. L. Courts, A.M.I.Prod.E.
P. G. Crabbe, M.I.Prod.E.
J. H. Cribb, A.M.I.Prod.E.
W. H. Crisp, A.M.I.Prod.E.
W. K. Cubbin, Stud.I.Prod.E.
C. E. Cummins, A.M.I.Prod.E.
J. Cunningham, M.I.Prod.E.
R. J. Currie, Grad.I.Prod.E.

F. S. Darling, Stud.I.Prod.E.
D. L. Davies, A.M.I.Prod.E.
J. Davies, Stud.I.Prod.E.
G. Davis, A.M.I.Prod.E.
R. Dent, A.M.I.Prod.E.
M. H. Dowler, Grad.I.Prod.E.
S. & E. Downie, Ltd.
N. Duffield, Stud.I.Prod.E.

N. C. Earll, A.M.I.Prod.E.
T. Edwards, Grad.I.Prod.E.
W. T. Ellis, A.M.I.Prod.E.
J. H. Ely, Stud.I.Prod.E.
L. Evans, Grad.I.Prod.E.

C. H. Fernandez, A.M.I.Prod.E.
N. Fitton, A.M.I.Prod.E.
D. T. J. Ford, Stud.I.Prod.E.
R. Foster, Stud.I.Prod.E.
G. Fox, A.M.I.Prod.E.

T. Garne, A.M.I.Prod.E.
C. W. Godridge, A.M.I.Prod.E.
A. Goodwin, Grad.I.Prod.E.
R. Grant, M.I.Prod.E.
F. Grey, A.M.I.Prod.E.
Messrs. Gummers, Ltd.
W. Gwinnett, M.I.Prod.E.
D. S. Gwynne, Grad.I.Prod.E.

R. J. Hall, Grad.I.Prod.E.
W. Hallit, M.I.Prod.E.
R. W. Hammond, Grad.I.Prod.E.
J. Harris, A.M.I.Prod.E.
R. Harris, Grad.I.Prod.E.
R. Harris, A.M.I.Prod.E.
W. G. Harris, Grad.I.Prod.E.
J. W. Haslam, A.M.I.Prod.E.
W. L. Hemer, A.M.I.Prod.E.
G. W. Hems, A.M.I.Prod.E.
C. E. Hendon, A.M.I.Prod.E.
A. G. Henry, Grad.I.Prod.E.
C. Heron, Grad.I.Prod.E.
A. Heston, A.M.I.Prod.E.
W. A. Hewitt, A.M.I.Prod.E.
F. T. Hill, M.I.Prod.E.
R. A. Hinckley, Grad.I.Prod.E.
R. D. Hind, Stud.I.Prod.E.
R. S. Hind, M.I.Prod.E.
A. Hindmarch, Stud.I.Prod.E.
D. Hitchings, Grad.I.Prod.E.
R. Holyoak, Stud.I.Prod.E.
C. W. Hotchem, A.M.I.Prod.E.
S. Hurstwaite, A.M.I.Prod.E.

T. I'Anson, A.M.I.Prod.E.
E. Innocent,

A. W. James, A.M.I.Prod.E.
W. W. Jeacock, A.M.I.Prod.E.
A. S. Johnstone, M.I.Prod.E.
A. D. Jones,Grad.I.Prod.E.
J. T. Jones, Grad.I.Prod.E.
R. A. Jones, Grad.I.Prod.E.
R. O. Jones, Grad.I.Prod.E.
R. T. Jones, Grad.I.Prod.E.

E. Kent, Grad.I.Prod.E.
P. Kerrin, Stud.I.Prod.E.
E. Knight, A.M.I.Prod.E.

R. Lamb, A.M.I.Prod.E.
S. G. Lane, A.M.I.Prod.E.
W. J. Lane, A.M.I.Prod.E.
J. H. Law, M.I.Prod.E.
J. A. Leek, Grad.I.Prod.E.
A. H. Lloyd.
W. S. Lockwood, A.M.I.Prod.E.
A. Lowson, A.M.I.Prod.E.
J. H. Lynn, A.M.I.Prod.E.

G. R. Marsh, M.I.Prod.E.
G. Matley-Bargent, A.M.I.Prod.E.
Prof. T. U. Matthew, M.I.Prod.E.
C. Matthews, A.M.I.Prod.E.
J. M. Meston, M.I.Prod.E.
B. McMahon, M.I.Prod.E.
W. G. Middleton, A.M.I.Prod.E.
E. G. Milner, A.M.I.Prod.E.
C. A. Minns, M.I.Prod.E.
R. Mitchell, M.I.Prod.E.
H. Moore, A.M.I.Prod.E.
H. E. Moore, A.M.I.Prod.E.
W. Moore, A.M.I.Prod.E.
A. F. Muir, M.I.Prod.E.
H. S. S. Murray, M.I.Prod.E.

D. S. Nicol, A.M.I.Prod.E.

R. S. Odd, M.I.Prod.E.
G. C. Oram, M.I.Prod.E.
J. Owens, Grad.I.Prod.E.

A. J. Pack, A.M.I.Prod.E.
S. G. Paddick, A.M.I.Prod.E.
E. Page, Grad.I.Prod.E.
D. E. Paget, A.M.I.Prod.E.
R. L. Paice, M.I.Prod.E.
M. H. Parkinson, Stud.I.Prod.E.
A. Partington, Grad.I.Prod.E.
J. Pedley, Grad.I.Prod.E.
F. W. Penny, A.M.I.Prod.E.
S. W. Perkins, M.I.Prod.E.
E. Phillips, Stud.I.Prod.E.
P. S. Pickles, A.M.I.Prod.E.
H. Podwell, A.M.I.Prod.E.
E. Poole, M.I.Prod.E.
R. Preston, A.M.I.Prod.E.

P. J. Quincey, A.M.I.Prod.E.

W. T. Ramsden, Grad.I.Prod.E.
W. E. Revell, M.I.Prod.E.
A. D. Riley, Grad.I.Prod.E.
R. J. Robins, Grad.I.Prod.E.
J. P. Robinson, A.M.I.Prod.E.
P. G. Robinson, Stud.I.Prod.E.
H. Rodwell, A.M.I.Prod.E.
D. B. Rolls, Stud.I.Prod.E.
B. A. J. Rule, A. M.I.Prod.E.
H. G. Rust, A.I.Prod.E.

E. R. Schofield, M.I.Prod.E.
J. Schofield, M.I.Prod.E.
A. T. H. Selby, Grad.I.Prod.E.
A. Sewart, M.I.Prod.E.
R. T. Shackleton, A.M.I.Prod.E.
C. R. Shotbolt, Grad.I.Prod.E.
R. C. Simmonds, Grad.I.Prod.E.
F. R. Simmons, A.M.I.Prod.E.
W. E. Simpson, Grad.I.Prod.E.
C. G. Sissons, A.M.I.Prod.E.
R. N. Sjorgren, A.M.I.Prod.E.
A. E. Smith, M.I.Prod.E.
E. E. Smith, A.M.I.Prod.E.
E. H. Smith, A.M.I.Prod.E.
Frederick Smith & Co., Ltd.
Smith Clayton Forge.
F. E. V. Spencer, M.I.Prod.E.
R. K. Stephenson, Stud.I.Prod.E.
L. V. Store, M.I.Prod.E.
W. Southall, Grad.I.Prod.E.
R. A. Straker-Nesbit, A.I.Prod.E.
D. P. Stratton, Stud.I.Prod.E.
E. Strong, A.M.I.Prod.E.
W. L. Stuart, M.I.Prod.E.
E. H. Sugden, A.M.I.Prod.E.

Hazleton Memorial Library

REVIEWS & ABSTRACTS

Members are asked to note that the Library will normally be open between 10 a.m. and 5.30 p.m. from Monday to Friday each week. It would be helpful if, in addition to the title, the author's name and the classification number could be quoted when ordering books.

Members are reminded that the Library service is available to all members of the Institution and the Librarian is always willing to assist with enquiries.

REVIEWS

"The Cold Working of Non-Ferrous Metals and Alloys : A Symposium on Metallurgical Aspects of the Subject." *London, Institute of Metals,* 1952. 207 *pages. Illustrations. Diagrams.* 15/-. (Monograph and Report Series No. 12.)

All users of metal must possess a certain amount of knowledge as to the best methods of working it. But how often does this knowledge enable the user to produce a good finished part? Or is this yet another case where the fundamental knowledge of the theorist still lags behind the practical experience of the operator? Even in these days of scientific enlightenment, it must be admitted that the design of tools for metal working is still largely based upon experience rather than on any established scientific data.

This is one of the reasons why this monograph makes fascinating reading, for it gives a first-class account of the methods employed by the theoretical metallurgist to capture this elusive "know how" of the practical man and to present it in scientific form. It records a symposium on metallurgical aspects of the subject when the leading non-ferrous metallurgists of this country foregathered to discuss the fundamental aspects of the cold working of metals, lubricants for the cold working of non-ferrous metals in the cold rolling of non-ferrous metals in sheet and strip form, wire drawing technique and equipment and the deep drawing and pressing of non-ferrous metals and alloys.

The first Paper, by Cook and Richards, differs from the other four in that it discusses the nature of the internal or structural changes involved in cold plastic deformation, rather than the technological aspects of the subject. This is an enlightening Paper on a subject where our fund of knowledge is still far from complete.

Lubrication, the subject of the second Paper by Chisholm, is of prime importance in the cold working of non-ferrous metals, for it is no exaggeration to say that the lubricant selected is the factor which determines, as much as any other, the success or failure of the operations. Here the processes of cold rolling, press drawing, tube drawing, and wire drawing are discussed from the point of view of the demands they make on lubricants, suitable lubricants being suggested in each case.

After reviewing recent progress in rolling practice, Davies, the author of the third Paper, describes modern technique in rolling copper and copper alloys and aluminium and light alloys. The relative merits of two-high, four-high, reversing, non-reversing, tandem and Sendzimir mills, are discussed and considerable attention is given to the auxiliary equipment required to handle sheet and strip during rolling. This Paper should help the user to realise to what extent the supplier goes in order to fulfil his particular needs, and the many troubles he has to contend with in executing such orders.

One section of particular interest in the Paper on wire-drawing by Cleaver and Miller is that relating to the various types of defects that are encountered in drawn wire. We know that they can exist, and it is nice to learn why.

The final Paper by Jevons on deep drawing discusses many things related to this subject. Terminology, methods, types of presses, tool material, lubricants, annealing, season-cracking, stretcher-strain markings, and suggested routine acceptance tests for sheet under industrial conditions are all dealt with.

Then follows forty pages of worthwhile general discussion of the type we all long for and so very seldom get.

This book should be read. One author admits that there are shortcomings and inadequacies in the existing relevant knowledge of the fundamental theoretical metallurgist, but points out that there is a need for the practical man to make better application of what is already known. There is a lot to be learnt here.

D.I.M.

Symposium on Aluminium Alloy Castings. *Birmingham and London,* 1952. *Proceedings. London, Aluminium Development Association,* 1953. 224 *pages. Illustrations. Diagrams.* 4/-.

The proceedings at a Symposium on Aluminium Alloy Castings held at the Queen's Hotel, Birmingham, on November 6th and Claridges' Hotel, London, on November 11th, 1952.

The nine Papers which were presented and discussed at both Birmingham and London form the first part of the book as an unbroken sequence. The subsequent discussions and authors' replies follow in the second half.

The Papers, which deal in particular with design problems and foundry technique in relation to requirements of users of aluminium alloy castings, are outlined as follows, and numerous photographs and diagrams are incorporated :-

"An Introduction to Aluminium Alloy Castings" by D. C. G. Lees, M.A., A.I.M.

"The Importance of Standards for Aluminium Alloy Castings" by E. Elliot, A.M.E.I., A.I.M., and F. H. Smith, A.I.M.

"A Survey of Some Researches on Aluminium Founding" by W. A. Baker, B.Sc., F.I.M.

"Developments in Finishing Aluminium Castings" by A. P. Tenn, A.M.I.Mech.E.

"The Assembly of Aluminium Components by Welding" by H. W. Keeble, A.I.M., Assoc.I.Mech.E.

"Recent Developments in Aluminium Foundry Practice" by E. Player.

"Some Interesting Aluminium Alloy Castings" by
1. A. Eyden, A.M.I.Mech.E.
2. G. L. Turners, B.Sc. J. W. James & A. Ratcliffe.

3. J. Caven.
4. H. C. Cross.
"The Design of Aluminium Alloy Castings" by L. Fletcher.
"The Future Outlook for Aluminium Castings" by L. R. Carr, M.A., M.P.

"Industrial Specifications" by E. H. MacNiece. *New York, Wiley; London, Chapman & Hall,* 1953. 158 *pages. Illustrations. Charts.* £1. 16. 0.

In this book the Author draws upon a wide personal experience to demonstrate to the reader how essential, to the modern technique of management, is the production of adequate specifications. Specifications covering most phases of industrial activity find their place within its covers.

The opening chapter is used by the Author to make comparison between the accuracy of measurement and the ability to specify. Chapters 2 and 3 are devoted to the relationship which must be established between the technical and economic factors of production. Within these chapters is found a clear and concise determination of tolerances, which is constructive to the student and forms a valuable reference for the engineer.

Chapter 3 also deals with the subject of co-operation, between the producer and buyer in the compilation of specifications. The process of sampling inspection, based upon the economic consideration of what inspection is necessary to give adequate protection to the buyer is dealt with in detail. Also in this chapter the terms "producer's risk" and "buyer's risk" are expounded. The chapter also establishes, in no uncertain terms, the benefits to be gained by predetermined standards of quality.

Chapters 4, 5 and 6, upon Standards, Standardisation and Simplification are of special interest to production engineers, as they deal with the establishment of standards for manufacture necessary to effect economy in production and distribution and, incidentally, stress the need for a standard of words, as well as terminology. The specimen raw material standard specifications cover material as far apart as drawn wire and waste rag, and illustrate clearly the value of detail specifications to both producer and buyer.

Chapter 7 concerns the Process Specification and emphasises the need for detail specifications that embrace every feature of operational procedure.

The concluding chapters are devoted to a wide range of specifications which include many for non-industrial products.

This book is the first upon this particular subject that has come to the reveiwer's attention and despite its typical American style, it should prove most useful to Student and Graduate Members. It is to be recommended also to many engineers, who have yet to appreciate the full significance of industrial specifications.

L.P.C.

"Accounts for Management: Some Aspects of Financial Control in Small and Medium Scale Business", by F. Clive de Paula and others. *Prepared for the British Institute of Management. London, The Institute,* 1954. 83 *pages. Charts.* 5/-. (Financial Management Series.)

This booklet has been specially prepared for the Institute by a panel of accountants well-known for their knowledge of and enthusiasm for accounting as an aid to management, but the authors make their position quite clear at the outset when they say that "accounts are not everything" and that "it is the manager himself who must make the decisions which mould the character of the business and provide its impetus".

The introduction states that the booklet is mainly for managers of small and medium undertakings, with the object of helping them to decide how accounts can aid them to make their businesses more efficient and smooth-running.

It is perhaps a sign of the times that this latest publication in the BIM's list is one in which the heading of a principal section is entitled: "Keeping the Business Profitable", and which starts off by discussing the £. s. d. of sales. Among other matters discussed are the desirability of knowing the degree to which each of one's products contribute to profit (or to loss) in various circumstances; depreciation and the replacement of plant under present day conditions; keeping stocks to the minimum; marginal costing; how to control expenditure; making money work; and how not to run out of money. Before he has turned over many pages the reader will begin to realise just how easy it is to apply the principles of budgetary control and standard costing in his own firm.

As befits a booklet for busy managers, this one is brief, substantially avoids technical terms, and concentrates on fundamentals which are of practical application. It is well arranged, in the form of a general text with six appendices which treat in more detail several of the matters discussed in the text. There are several charts, and many tables of examples illustrating the subjects discussed. The charts and tables are brief and, with the possible exception of those on pages 15, 16, and 17, illustrating the effect of external conditions on the relative profitability of several products, are all admirably clear and understandable. The booklet ends with a reading list.

"Accounts for Management" is an excellent booklet, likely to be of great help and interest to most managers —and probably to many accountants also. Production engineers will find that by reading this booklet they will quite painlessly acquire background information which they should not be without. C.H.S.

"The Tool Steel Trouble-shooter: An Analysis of 107 Tool Failures." *Bethlehem Steel Company, Bethlehem, Pa. Bethlehem, the Company,* 1952. 123 *pages. Illustrations.*

The booklet is written in simple language and is free from advertising material. The basic causes of tool failure are analysed under five main headings, viz.: design, steel, heat treatment, grinding and operational. These factors are treated in varying degrees of thoroughness with heat treatment far more exhaustively analysed than the rest; the sections on grinding and operational factors are only given cursory examination.

An outstanding feature of the book is the large number of photographs, illustrating the various causes of failure.

The section dealing with design errors is confined to stressing the need for avoiding sudden changing of section, sharp corners, improper clearances and high stresses due to too-small tool sections. In the steel failure section, the danger of poor carbide distribution causing problems is pin-pointed, and its overcoming by using small diameter bar stock direct or as upset forgings for larger diameters such as milling cutters.

The information on faulty heat treatment is given with a minimum of strictly metallurgical phraseology and should prove most useful to tool designers and heat treatment personnel. The fundamentals of heat treatment are given first and this is followed by explanations of the most common errors of cutting tools and dies.

Sections on grinding and operation offer little new information to those with experience of cutting tools and dies. E. C.

"Grading of Clerical Work." Office Management Association, London. *London, the Association,* 1953. 96 *pages.* £1. 1. 0.

This booklet aims at giving an office manager a practical means of assessing the calibre of clerks he needs to do the various tasks in his office. It shows him the value of doing so and provides a simple yardstick whereby he can do it. Not only that, it provides detailed specifications for the majority of clerical jobs, covering all the more usual procedures such as Cash Control, Payroll, Certification of Bought Invoices and

Bought Ledgers, Sales Invoices and Sales Ledgers, Typing and Shorthand. Each of the fifteen such procedures is analysed under a large variety of possible tasks, and indicates the calibre of clerk required for each task by assigning to it one of the six job grades which the Office Management Association have used since 1942 as the basis for their job grading.

There is also a chapter on how an office manager may assign a merit rating to clerks, according to the varying degree of skill and experience with which the clerks do the job in a grade.

Another chapter explains in detail how an office manager may introduce a job grading and merit rating scheme into an office which has not previously had one, and how salary scales can be devised which reflect the responsibilities and capabilities of the clerks. It also explains the care with which the scheme must be introduced to the supervisors and clerks so as to win their co-operation. In this way the scheme can become a firm foundation for the future selection, development, promotion and remuneration of the clerks of the office. S. C.

" European Foundries and Productivity: Some Recent Experiments and Achievements". *Paris, Organisation for European Economic Co-operation,* 1953. 268 *pages. Illustrations. Diagrams.* 14/-.

This publication contains proceedings of the first European Seminar on Foundry Productivity arranged by the Organisation for European Economic Co-operation. Twelve European countries, including the United Kingdom, participated and a number of American experts attended at the invitation of O.E.E.C.

The theme running through the conference seemed to be the impressions and experiences of different countries' productivity teams which visited the United States, together with the application and results of this information when applied to foundries in Europe.

Different countries presented Papers on the same subject, e.g. the publication contains three Papers on human relations and seven Papers on improved working by rational organisation and mechanical handling. It naturally follows, therefore, that there is a certain amount of repetition throughout this book.

It contains a host of useful information to the foundryman, particularly in relation to the attitude of European foundries towards similar problems encountered in British foundries. There are seven Papers on specific instances of better productivity within foundries, five Papers on the part technical advisory services play in improving productivity, seven Papers on improved working by rational organisation and mechanical handling, three Papers on the problems of human relations and four Papers on the attitude of the various national foundry industries towards productivity.

The information contained in this publication is so comprehensive that both the student and the managing director would be well justified in taking time to read it. A.S.

OTHER ADDITIONS

621.791 WELDING, CUTTING

Reynolds Metals Company, *Louisville, Ky.* **" Welding Aluminium."** *Louisville, the Company,* 1953. 185 *pages. Illustrated. Diagrams.*

621.794 SURFACE TREATMENT OF METALS

Harris, Jay C. **" Metal Cleaning Bibliographical Abstracts, 1842-1951."** *Philadelphia, A.S.T.M.,* 1953. 132 *pages.* $4.25. (Special Technical Publication, No. 90-B.)

621.795 SURFACE PROCESSES; FINISHING

Ousbey, John Howell. **" Cellulose Spraying: a Guide to Finishing Motor Cars and other Metal Surfaces with Cellulose and Synthetics."** Second edition. *London, Pitman,* 1952. 92 *pages. Illustrated. Diagrams.* 10/6d. (Automobile Maintenance Series.)

Reynolds Metals Company, *Louisville, Ky.* **" Finishes for Aluminium."** *Louisville, the Company,* 1951. 124 *pages. Illustrated.*

621.82 TRANSMISSION OF POWER

" Manual of Mechanical Power Transmission." Third edition. *London, Trade and Technical Press,* 1953. 631 *pages. Illustrated. Diagrams.*

621.83 GEARS

Bakelite Ltd., *London.* **" Bakelite Laminated Gears."** *London, the Firm,* 1953. 28 *pages. Illustrated. Diagrams.*

Wakefield, C. C., & Co. Ltd., *London.* **" Gear Lubrication."** *London, the Company,* 1953. 112 *pages. Illustrated. Diagrams.* (Wakefield-Dick Technical Series.)

621.855 CHAIN TRANSMISSION

Renold and Coventry Chain Company Ltd., *Manchester.* **" Power Transmission Diagrams and Technique."** *Manchester, the Company,* 1953. 100 *pages. Illustrated. Chart.*

621.86 MATERIALS HANDLING

Marton Air Equipment Ltd., *Richmond, Surrey.* **" Marton Air Hoist Instruction Manual."** *Richmond, the Firm* (1953). 16 *pages. Illustrated.*

Material Handling Institute, *Pittsburgh, Pa.* **" Material Handling."** *Pittsburgh, the Institute,* 1952-3. Three parts. *Illustrated. Diagrams.* 50c. each. (Library of Know-how.)

621.89 LUBRICATION; CUTTING FLUIDS

Herbert, Alfred, Ltd., *Coventry.* **" Lubricants and Cutting Fluids."** Third edition. *Coventry, the Firm,* 1953. 15 *pages. Illustrated. Diagrams.*

Production Engineering Research Association of Great Britain, *Melton Mowbray, Leics.* **" Properties of Soluble Cutting Oils; Tests on Soluble Cutting Oils, Part I."** *Melton Mowbray, the Association,* 1949. 61 *pages. Illustrated. Diagrams.*

621.9 MACHINE TOOLS; MACHINING

Kaplan, Julius Y. **" Automation of Machine Tools."** *Detroit, American Society of Tool Engineers,* 1953. 21 *pages. Illustrated. Diagrams.*

" Machining Operations on Shells." *London, Machinery Publishing Co. Ltd.* [n.d.] 53 *pages. Illustrated. Diagrams.* (Machinery's Yellow Back Series, No. 11.)

Political and Economic Planning, *London.* **" The Machine Tool Industry."** *London, PEP,* 1948. 179-194 *pages.* (*Planning,* Vol. 15, No. 292. December 20, 1948.)

Bakelite Ltd., *London.* **" Machining Bakelite Laminated."** *London, the Company* (1953). 65 *pages. Illustrated.*

High Duty Alloys Ltd., *Slough, Bucks.* **" Hiduminium and Maguminium Alloys: Machining Notes."** *Slough, the Firm,* 1953. 15 *pages. Diagrams.*

Reynolds Metals Company, *Louisville, Ky.* **" Machin- Aluminium Alloys."** *Louisville, the Company,* 1952. 124 *pages. Illustrated. Diagrams.*

002 DOCUMENTATION

Holmstrom, J. Edwin. **" Facts, Files and Action in Business and Public Affairs "; Part I. " Sources and Background of Facts."** *London, Chapman & Hall Ltd.,* 1951. 450 *pages.* £1. 16. 0.

140 PHILOSOPHY

Jewson, K. S. **" Production—My Job."** *Dereham, Norfolk, L. F. Everett,* 1953. 16 *pages.*

159.9 PSYCHOLOGY

Fraser, John Munro. **" Understanding Other People: The Five-fold Grading Method."** *London, Pitman,* 1953. 58 *pages.* 3/-. (The Supervisor's Guides, No. 2.)

The Council of the Institution

1954/55

President
Sir Walter Puckey

Chairman of Council
G. R. Pryor

Vice-Chairman of Council
H. G. Gregory

Immediate Past Chairman of Council
H. Burke

Past Presidents
Major-General K. C. Appleyard, C.B.E. Sir George Bailey, C.B.E. Sir Alfred Herbert, K.B.E. Sir Ernest Lemon, O.B.E. Norman Rowbotham, C.B.E. The Rt. Hon. Viscount Nuffield, G.B.E. J. D. Scaife Dr. H. Schofield, C.B.E. The Rt. Hon. Lord Sempill, A.F.C. Tom Thornycroft Sir Cecil Weir, K.C.M.G., K.B.E., D.L.

Overseas Council Presidents
AUSTRALIAN COUNCIL—J. N. Kirby
SOUTH AFRICAN COUNCIL—W. G. Gillespie

Chairmen of Regional Committees

East & West Ridings
J. E. Hill
Eastern
J. B. Webster
Midlands
H. Burke
North Midlands
J. C. Routledge

Northern
T. McCulloch
North Western
F. W. Cranmer
Northern Ireland
J. Ringland
Scotland
M. C. Timbury

South Eastern
R. E. Leakey
Southern
F. T. West, M.B.E.
South Western
E. F. Gilberthorpe
Wales
H. T. Jones

Additional Representatives on Council

East & West Ridings
F. T. Nurrish, M.B.E.
Midlands
S. J. Harley

North Western
J. France
South Eastern
R. Telford

Chairmen of Standing Committees
W. J. T. Dimmock B. H. Dyson C. M. Holloway C. L. Old S. A. J. Parsons M. Seaman
The Rt. Hon. Lord Sempill, A.F.C.

Elected Members
A. J. Aiers H. W. Bowen, O.B.E. R. S. Brown R. M. Buckle A. G. Clark R. S. Clark Wm. Core B. H. Dyson E. P. Edwards F. J. Everest R. S. Hind B. G. L. Jackman R. Kirchner Prof. T. U. Matthew B. E. Stokes A. L. Stuchbery C. Timms R. H. S. Turner

Overseas Section Chairmen

Bombay
E. H. Y. Burden
Canada
C. J. Luby

Calcutta
B. F. Goodchild
N. Zealand
J. A. Holmes

Overseas Councils

AUSTRALIA

President
J. N. Kirby

Chairman
J. H. Law

Vice-Chairman
H. G. Sutton

Elected Members
R. W. Deutsher S. Downie N. Eaton N. Esserman W. M. B. Fowler W. Gwinnett W. L. Hemer E. Herbert J. O. Ogden C. Pullen B. G. Ross J. E. Strick A. Welsh L. W. Worthington

SOUTH AFRICA

President
W. G. Gillespie

Vice-President
H. J. G. Goyns

Past Presidents
B. Anderson R. H. Arbuckle L. H. L. Badham G. Godfrey J. Henry D. Lion-Cachet J. Renwick A. C. Wotherspoon

Elected Members
G. T. Chawner D. N. S. Clare V. J. S. Donnelly C. O. Doehring D. E. Hamm D. A. Petrie G. M. Pratley P. L. Ward H. H. Waters

REGIONAL HONORARY SECRETARIES

East & West Ridings ...	Miss N. E. Bottom	**Northern Ireland**	W. G. Wyman
Eastern	R. Craven	**Scotland**	W. H. Marley
Midlands	B. W. Gould	**South Eastern**	R. Hutcheson
North Midlands	D. G. Swinfield	**Southern**	J. W. Taylor
Northern	C. C. Hodson	**South Western**	A. Eustace
North Western	G. R. Parker	**Wales**	W. D. Porter

Secretary of the Institution
W. F. S. Woodford

SECTION HONORARY SECRETARIES

AUSTRALIA

Adelaide (South Australia) ...	W. L. Hemer, 6 Bedford Street, Brooklyn Park, South Australia.
Melbourne (Victoria Australia) ...	R. W. Deutsher, Bank House, 11 Bank Place, Melbourne, C.I., Victoria Australia.
Sydney (N. S. Wales)	A. Welsh, Room 802, 16 Barrack Street, Sydney, Australia.

CANADA

Canada	P. M.Wood, 31 Conway Avenue, Toronto, 10, Ontario.

INDIA

Bombay	S. V. Krishnamurty, c/o Machine Tools (India) Ltd., Imperial Chambers, Wilson Road, Post Box 522, Bombay 1, India.
Calcutta	N. N. Sen Gupta, 110 Surrendra Nath, Banerjee Road, Calcutta 13.

NEW ZEALAND

New Zealand	H. R. Holmes, Pah Road, Papatoetoe, Auckland.

SOUTH AFRICA

South Africa	The Secretaries, Institution of Production Engineers, Barclays Bank Buildings, Corner Commissioner and Harrison Streets, Johannesburg.

UNITED KINGDOM

Birmingham	B. W. Gould, Dept. of Industrial Administration, College of Technology, Suffolk Street, Birmingham.
Cornwall	F. G. Hawke, 17 Church Road, Pool, Redruth, Cornwall.
Coventry	W. G. Key, 128 Green Lane, Coventry.
Derby	P. Warburton, 27 Albemarle Road, Chaddesden, Derby.
Doncaster	W. H. Edwards-Smith, 32 Westmoreland Street, Balby, Doncaster.
Dundee	K. Fairweather, c/o D. Morrison, 13 Kerrsview Terrace, Dundee, Angus.
Eastern Counties	A. B. Brook, Davey, Paxman & Co. Ltd., Britannia Works, Colchester.
Edinburgh	A. Atkinson, Priory House, South Queensferry, West Lothian.
Glasgow	W. H. Marley, G. & J. Weir, Ltd., Coltness Foundries, Newmains, Lanarks.
Gloucester & District	P. C. Bradshaw, Woodland View, Norton, Glos.
Halifax	Miss N. E. Bottom, Hopkinsons Ltd., Huddersfield.
Leicester & District	D. G. Swinfield, 65 St. Saviour's Road, Leicester.
Lincoln	H. Wright, 101 Longdales Road, Lincoln.
Liverpool	R. T. Spencer, 44 The Beech Walk, Knottyash, Liverpool 14.
London	R. Hutcheson, Machine Shop Magazine, Dorset House, Stamford St,, London, S.E.1
Luton	J. F. W. Galyer, Engr. Dept., Luton & South Beds. College of Further Education, Park Square, Luton.
Manchester	G. R. Parker, 722 Ripponden Road, Moorside, Oldham.
North Eastern	G. D. Robinson, 27 Holme Avenue, Newcastle-on-Tyne 6.
Northern Ireland	W. G. Wyman, "Linden Lea", Cultra, Co. Down, N. Ireland.
Norwich	F. H. S. Heidenstam, 33 Cecil Road, Norwich.
Nottingham	C. N. T. Manfull, Chellaston House, Thurgarton Street, Nottingham.
Oxford	M. J. Inston, 53 Rymers Lane, Cowley, Oxford.
Peterborough	E. G. Perrett, 165 St. Pauls Road, Peterborough.
Preston	R. Thompson, 71 Willows Lane, Accrington, Lancs.
Reading	R. W. H. Mark, "The Beeches", 41 Reading Road, Woodley, Berks.
Rochester & District	W. G. Clements, 11 Charing Road, Gillingham, Kent.
Sheffield	T. F. Newton, 20 Exley Avenue, Sheffield 6.
Shrewsbury	W. M. Buchan, Llanberis, Mytton Oak Road, Shrewsbury.
Southern	J. W. Taylor, 44 Deacon Road, Bitterne, Southampton.
S. Essex	P. H. W. Eeveritt, 6 Hillcrest Road, Loughton, Essex.
South Wales & Mon.	W. D. Porter, 49 Kyle Avenue, Rhiwbina, Cardiff.
Stoke-on-Trent	R. Rowley, North Staffordshire Technical College, Stoke-on-Trent.
Tees-side	T. A. Horsley, 24 Clarence Road, Nunthorpe, Nr. Middlesbrough.
Western	A. Eustace, 19 Ferndale Road, Northville, Bristol 7.
West Wales	H. P. Sanderson, I.C.I. Ltd. (Metals Division), Waunarlwydd, Nr. Swansea.
Wolverhampton	W. B. Pamment, Wolverhampton & Staffordshire Technical College, Wolverhampton.
Worcester	R. Wheeler, Old Farm House, Parish Hill, Bournheath, Nr. Bromsgrove, Worcs.
Yorkshire	J. L. Townend, 26 Moor Allerton Drive, Street Lane, Leeds 7.

CORRESPONDING MEMBER IN MIDDLE EAST

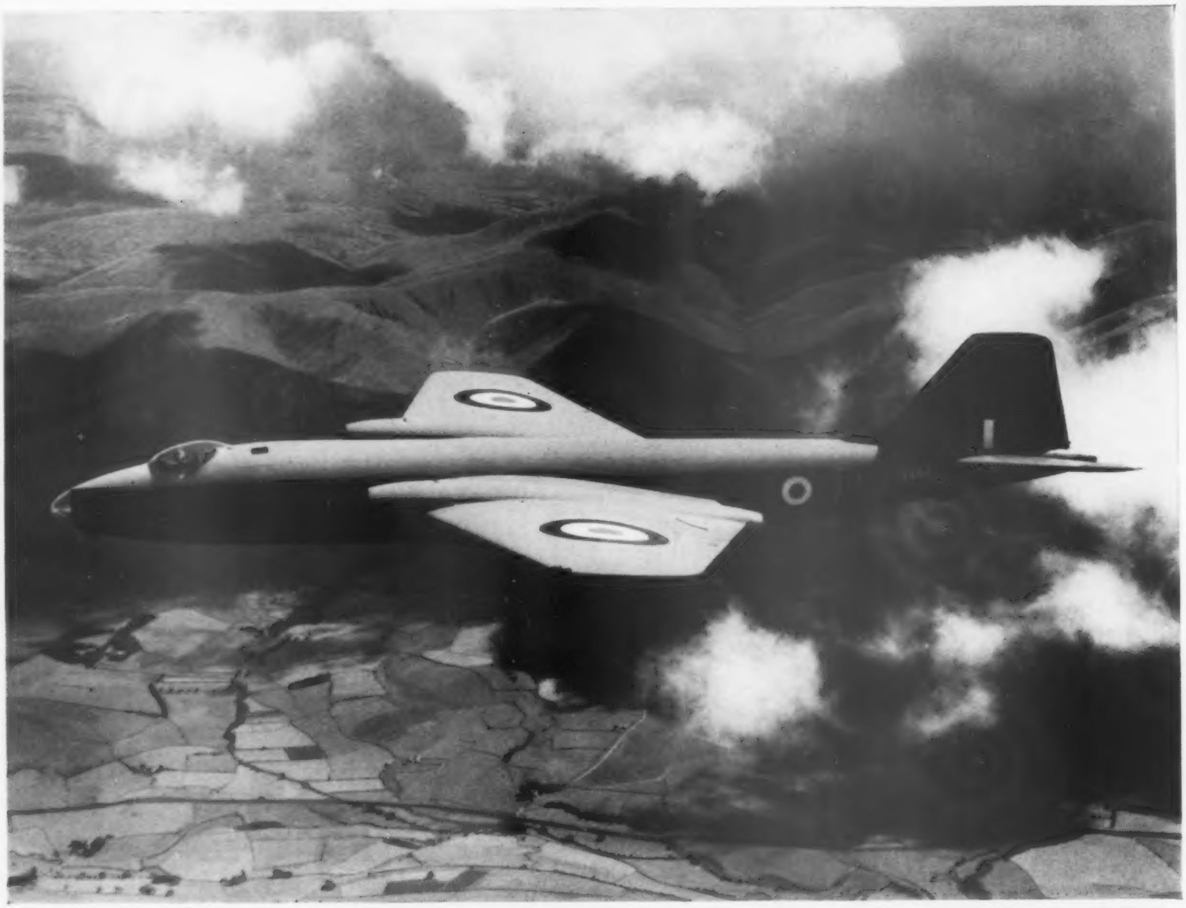
J. Merkine, 45 Arlozoroff Street, Ramat-Gan, Israel.

CORRESPONDING MEMBER IN EGYPT

A. F. Aboo, 29 Abo Taleb Street, Terha Bolackia, Shouba, Cairo.

GRADUATE SECTION HONORARY SECRETARIES

Birmingham	R. D. Guthrie, 90 Park Road, Quarry Bank, Brierly Hill, Staffs.
Coventry	A. S. Hopkins, 83 Clinton Lane, Kenilworth, Warwicks.
Halifax	C. W. Overin, 353 Whitehall Road, Westfield, Wyke, Nr. Bradford.
Liverpool	G. L. Smith, 17 Withers Street, Liverpool 7.
London	L. J. Saunders, 12 Woodfield Road, Ealing, London, W.5.
Luton	F. G. Ethelston, c/o 106 Argyll Avenue, Luton, Beds.
Manchester	D. Allott, 47 Williams Crescent, Chadderton, Nr. Oldham, Lancs.
North Eastern	R. F. Loebl, 32 Deneside Avenue, Low Fell, Gateshead-on-Tyne 9.
Sheffield	G. Shaw, Horseshoe Cottage, Holmesfield Road, Nr. Sheffield.
Western	R. W. Wall, 6 Filton Avenue, Horfield, Bristol 7.
Wolverhampton	W. L. Pace, "Linden", 10 Ezekiel Lane, Short Heath, Willenhall, Staffs.
Yorkshire	R. C. Taylor, 91 Broadgate Walk, Horsforth, Nr. Leeds.



'English Electric' Canberra
(Photograph by permission)

Another HI-TON *Success Report*

There are few instances which have proved more successful than the installation of HI-TON presses at *Gestetner* Ltd., Tottenham, where these machines are being used for delicate pressing operations on duplicator screens and protectors. Precision assembly, high output and ease of operation are valued features of the installation.

By courtesy of
Gestetner Ltd.,
Tottenham.

MODELS FROM I TO 250 TONS

HI-TON
HYDRAULIC PRESSES

For Speeding up Production Assembly

FULL PARTICULARS ON REQUEST

Sales and Service . . . **DRUMMOND-ASQUITH** *. . . in the British Isles.*

DRUMMOND-ASQUITH (SALES) LTD., KING EDWARD HOUSE, NEW ST., BIRMINGHAM
'Phone : Midland 3431 (5 Lines) *Also at LONDON & GLASGOW*

Anderson

British Built

Wiedemann Hand[r]

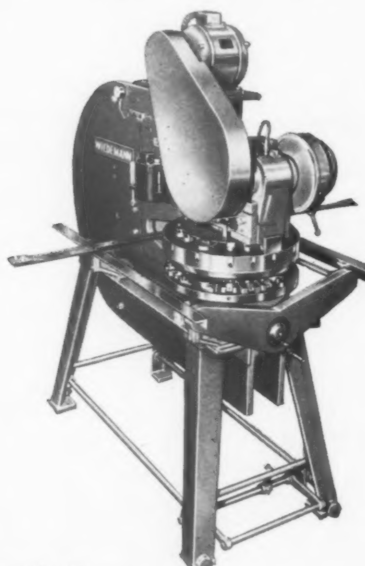
for Production o[h]

Type RA - 41P Power-Operated
(Illustration shows Press fitted with pantograph type table)

Depth of throat	28″
Number of Stations	16 to 20
Maximum punch diameter	3⅛″

Type R - 41P Power-Operated
(Illustration shows Press fitted with Standard Gauge Attachment)

Depth of throat	28″
Number of Stations	16 to 20
Maximum punch diameter ...	3⅛″



Type R - 7 Power-Operated
(Illustration shows Press fitted with a Direct Measuring Gauge Table 60″ x 120″ capacity)

Capacity	160,000 lbs.
Depth of throat	60″
Number of Stations	32
Maximum punch size	6″ x 6″

Send for Detailed Catalogues

BRITISH-BUILT TO THE ORDER OF

DOWDING & DOLL LTD

346 KENSINGTON HIGH STREET, LONDON, W. 14

Telephone WESTERN 8077 (8 lines) *Telegrams* · ACCURATOOL HAMMER LONDON

63

continuous COPPER BRAZING FURNACES with REMOVABLE elements

Birlec Limited can now offer continuous copper brazing furnaces with removable non-metallic elements as standard equipment. Extensive production trials have taken place and the following advantages proved:—

★ ***Element replacement is easy and can take place, if necessary, while the furnace is in operation.***

★ ***Element replacement does not involve rebricking, and expensive downtime is thus reduced.***

★ ***Element life is no shorter than with conventional nickel-chromium resistors.***

...also INDUCTION HEATING

For brazing a small part to a large article, induction heating equipment is the answer; localised heat means no wasted heat and a "machine tool" approach to equipment design makes the process ideal for quantity-production methods. The Birlec Induction Heating Division will be glad to advise on individual applications.

Illustration left: A standard 5kW unit, for brazing carbide tool tips.

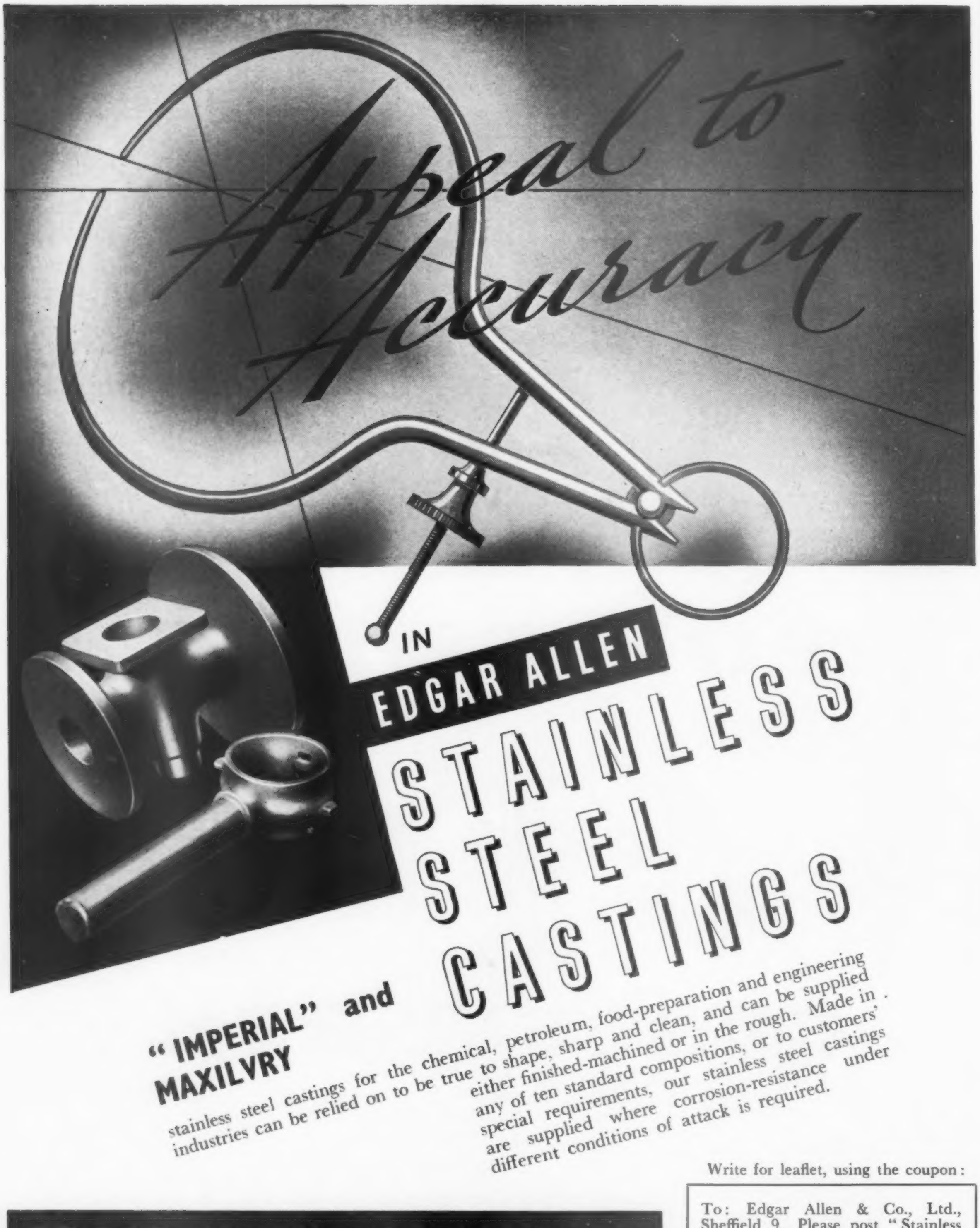
Designs are completed for standard 6", 8" and 12" furnaces; may we send details? We should also be pleased to arrange a visit to our Heat Treatment Division, near the main works in Tyburn Road, where test pieces can be brazed in a furnace of this type.

BIRLEC LIMITED

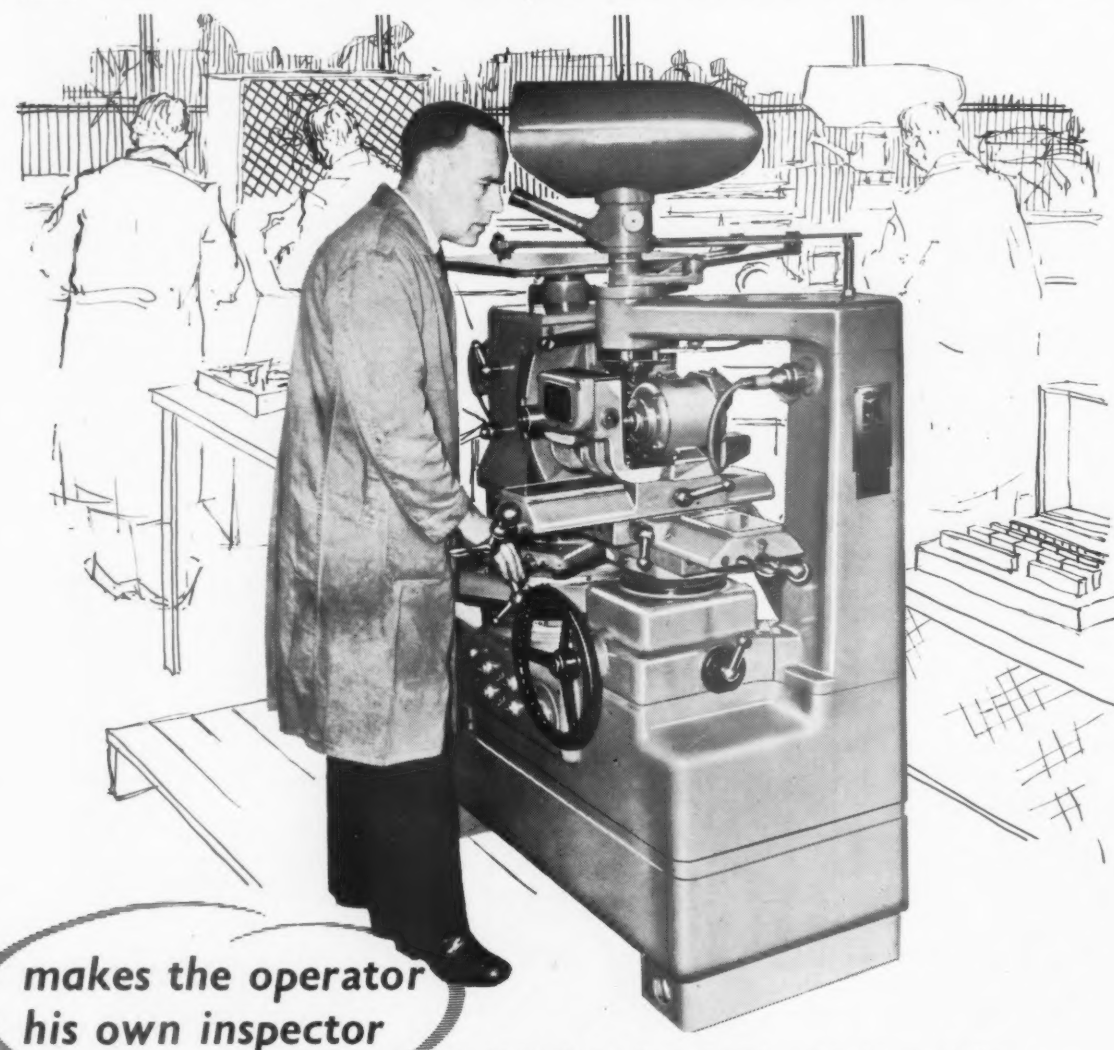
ERDINGTON • BIRMINGHAM • 24

Sales and service offices in **LONDON • SHEFFIELD • NEWCASTLE-ON-TYNE • GLASGOW**

SM/B.2134.54


Appeal to Accuracy
IN
EDGAR ALLEN
STAINLESS
STEEL
CASTINGS
" IMPERIAL" and
MAXILVRY
stainless steel castings for the chemical, petroleum, food-preparation and engineering industries can be relied on to be true to shape, sharp and clean, and can be supplied either finished-machined or in the rough. Made in any of ten standard compositions, or to customers' special requirements, our stainless steel castings are supplied where corrosion-resistance under different conditions of attack is required.
Write for leaflet, using the coupon:
To: Edgar Allen & Co., Ltd., Sheffield 9. Please post "Stainless Steels" Booklet to:—
Name ....
Firm ....
Address ....
....
I.P.E.
EDGAR ALLEN & CO·LIMITED
IMPERIAL STEEL WORKS:-SHEFFIELD·9
TELEPHONE: SHEFFIELD 41054. TELEGRAMS: ALLEN, SHEFFIELD 9

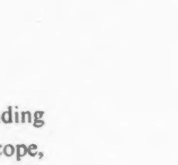
THE WICKMAN OPTICAL PROFILE GRINDING MACHINE



makes the operator his own inspector

Combining the functions of a universal toolroom grinding machine, a fifty-to-one pantograph, and a microscope, this machine will not only produce the most intricate profiles and die-forms in a single operation, but enables the operator to check the accuracy of the form produced as the work proceeds.

Accuracy is not affected by wheel wear and specially shaped wheels are not required. Attachments are available for circular form grinding and indexing.



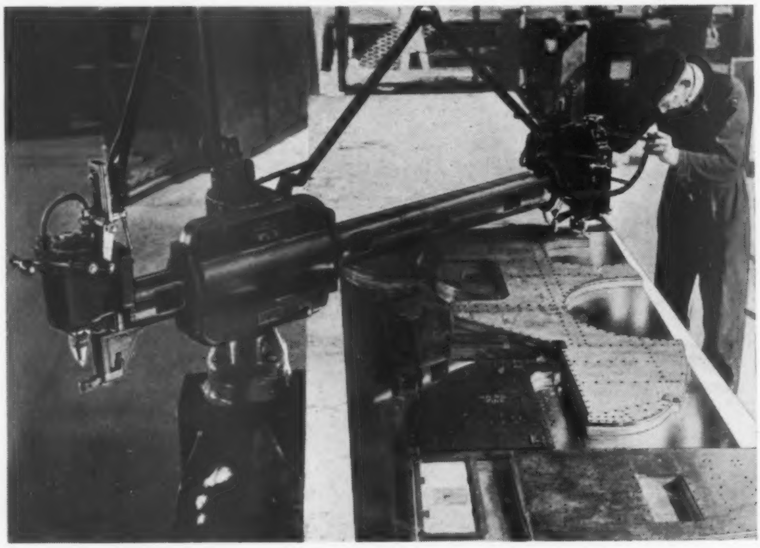
Write for this catalogue and get full details.

WICKMAN *of* COVENTRY

WICKMAN LIMITED, MACHINE TOOL DIVISION, BANNER LANE COVENTRY, ENGLAND. *Telephone: Tile Hill 66271*

350 WMG

The way Aircraft Firms machine Non-ferrous Metals



With the Wadkin Radial Arm Router, not only can large components be worked, but a number of small patterns can be grouped together, so as to cut out of a large sheet economically. Several sheets can be cut at one setting and fast rates of production maintained without highly skilled labour. With our unrivalled experience and knowledge of routing non-ferrous metals, we should be glad to advise on the application of Wadkin Routers to your class of work; meanwhile, write for a copy of leaflet No. 536.

Routing components from a large sheet of material in the Brough works of the Blackburn and General Aircraft Ltd.

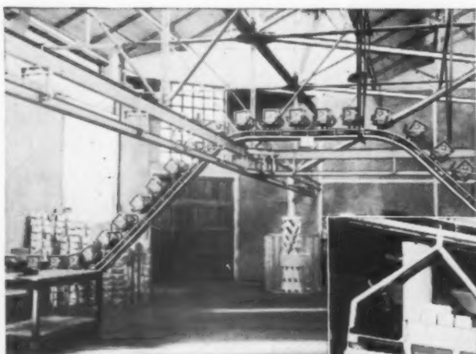
The machine is a combined Router and Drill, Type L.E.G. All Wadkin Radial Arm Routers are prepared to receive the drill head when required.

Wadkin

Telephone: Leicester 67114
Telephone: Mayfair 7048-9

Wadkin Ltd., Green Lane Works, Leicester. London Office: 62 Brook St., W.1.

DUAL-DIRECTIONAL CONVEYOR SYSTEMS



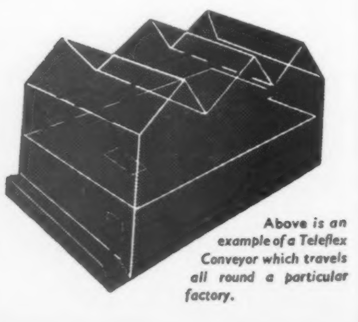
Now thoroughly proved in service with some of the most well-known manufacturers the Teleflex Dual-directional Chain Conveyor can be supplied soon after receipt of your order. The design is simple, efficient, well proportioned and perfectly balanced.

Teleflex Conveyor systems are constructed from standardised units which are capable of being formed into individual systems to suit any particular factory or production layout.

Write for illustrated brochures: Cable Conveyors ref: Con. I.P.E. and Chain Conveyors ref: Con. 2 I.P.E.

Above: *The Teleflex Dual-directional Chain Conveyor adapted to carry tins of biscuits.*

Right: *Overhead Chain Conveyor carrying cigarettes in packing and despatch departments at the factory of Messrs. W.A. & A.C. Churchman.*



Above *is an example of a Teleflex Conveyor which travels all round a particular factory.*

TELEFLEX PRODUCTS LTD · UPHALL RD. · ILFORD · ESSEX

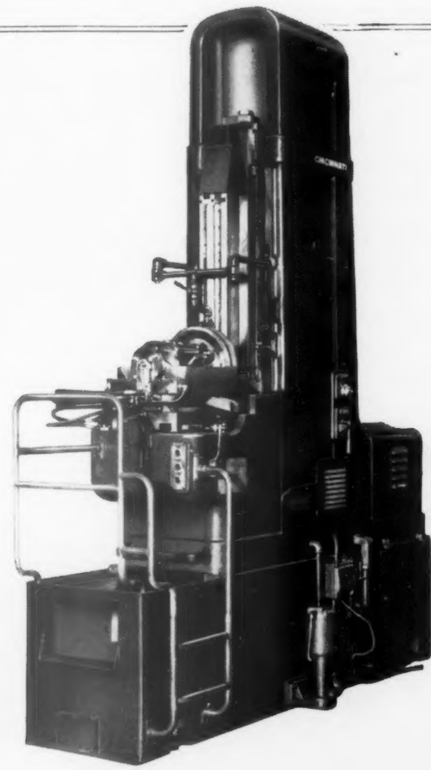
TELEPHONE ILFORD 3117

CINCINNATI APPLICATIONS IN MODERN INDUSTRIAL PRODUCTION

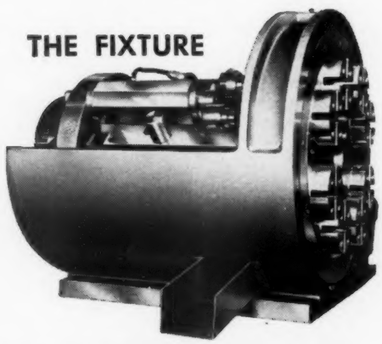
Raleigh Cycles broach four slots in a cycle component on a Cincinnati Single Ram Surface Broaching Machine.

THE COMPONENT

Using the special 8-station Automatic Indexing Fixture the four Slots in this cycle component are broached and the parts automatically ejected at a production rate of 400 pieces per hour.



THE FIXTURE



The 8-station Automatic Indexing Fixture, designed by CINCINNATI application engineers, enables the Raleigh Company to attain their machining target for this component.

THE MACHINE

A CINCINNATI Single Ram Surface Broaching Machine, 5 Tons pressure, 54" stroke, capable of high production at low cost per piece with maximum accuracy and long tool life.

Send for Bulletin SDB 5205 which outlines the advantages of Surface Broaching.

Cincinnati Surface Broaching Machines

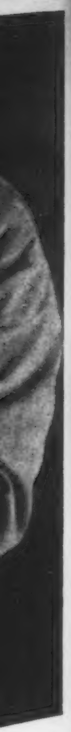
SINGLE AND DUPLEX RAMS

CINCINNATI MILLING MACHINES LTD., BIRMINGHAM, 24

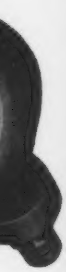
Distributing agents for U.K. and Northern Ireland: Charles Churchill & Co. Ltd. Birmingham, 25

INDEX TO ADVERTISEMENTS

All communications regarding advertisements should be addressed to the Advertising Managers, T. G. Scott & Son, Ltd.
Crown House, 143-147, Regent Street, London, W.1. Phone: Regent 3891.
Printed by Maxwell, Love & Co. Ltd., White Lion Street, London, N.1.



MPACT
smooth,
afe and
ywhere.



erator.

ds, oil

ents —

eeding

there

OOLS

BORNE
HE14

td.

J

INS

T
li

p
p
a

o
fi
it

C
h
h
I
f
C

c
t
c

t
V
1

JOURNAL SUPPLEMENT

Vol. 33, No. 8
August, 1954

INSTITUTION OF PRODUCTION ENGINEERS, 10, CHESTERFIELD ST., LONDON, W.1

ANNUAL DINNER 1954

The Institution's Annual Dinner, 1954, will be held in the

DORCHESTER HOTEL, LONDON
on
FRIDAY, 8th OCTOBER, 1954

Tickets, price 45/- each (excluding wines) may be ordered on the form printed overleaf. Owing to limited accommodation it is not possible to have lady guests. Tickets are available for members and gentlemen guests.

PRODUCTION CONFERENCE, OLYMPIA, 1954

A full report of the proceedings of the Production Conference held at Olympia last month, including the papers presented and the subsequent discussions, will be available towards the end of September as a separate publication, price one guinea, post free. Members and others who wish to obtain copies of this report are asked to make early application to the Secretary, 10, Chesterfield Street, London, W.1., using the form overleaf.

MATERIALS HANDLING CONFERENCE
"TO—THRO'—OUT"

In their investigations into materials handling practice in Britain, the Materials Handling Sub-Committee of the Institution have been concerned at the lack of subject matter on handling which is useful to the smaller firm. A great deal of the information and publications available are applicable only to large concerns, and it is one of the primary aims of the Sub-Committee to do what they can to remedy this deficiency.

As a contribution to this end, a one-day conference is being arranged, under the auspices of the Sub-Committee, and will be held at the works of John Wright & Company (Radiation) Limited, Aston, Birmingham, 6, on Saturday, 23rd October, 1954. The theme of the Conference is "TO - THRO' - OUT"—the handling of materials and components *TO* the factory, *THRO'* the factory, and *OUT* of the factory. The Institution is indebted to J. Ivan Yates, Esq., Chairman of the Birmingham Production Centre, Radiation Ltd., for extending the hospitality of the company and full facilities of their offices and works for this important Conference.

Full details of the Conference programme, which will allow time for free discussion and interchange of information, will be published shortly, but members who would like to attend the Conference are advised to make early application, using the form overleaf. Admission will be by programme only, (5/-), which includes copies of all papers to be presented.

There will also be, in conjunction with the Conference, a small Exhibition of photographs illustrating the theme of the Conference. Affiliated firms who are willing to loan photographs for this purpose are invited to contact Mr. C. M. P. Willcox, A.M.I.Prod.E., at P. L. Willcox, Ltd., Standard Works, Tyseley, Birmingham, 11.

ANNUAL DINNER

FROM *(Please use block letters).*	Date rec'd at I.Prod.E.
	Receipt sent :-
	Ticket(s) sent :-

To: THE SECRETARY, THE INSTITUTION OF PRODUCTION ENGINEERS,
10, CHESTERFIELD STREET, LONDON, W.1.

Please send me a ticket for myself and...........tickets for my guests whose names are given below :-

Names of guests .... Titles, Honours, Degrees, etc. ....

....

....

(additional names may be entered on separate slip).

If possible, I should like to sit at the same table as, or adjacent to, the following members :-

....

I enclose remittance for £ : : (.........ticket(s) at 45/- each).

N.B.—Cheques, etc. should be crossed and made payable to the Institution of Production Engineers.

To: THE SECRETARY,
THE INSTITUTION OF PRODUCTION ENGINEERS,
10, CHESTERFIELD STREET,
LONDON, W.1.

Please send me, when available.........copy/copies of the Report of the Production Conference, 1954, at £1. 1. 0. each, post free, for which I enclose a remittance of £..............

NAME..

ADDRESS..

....

Cheques and Postal Orders should be made payable to The Institution of Production Engineers.

PLEASE NOTE:
No acknowledgment of this Order will be made, other than the official receipt.

To: THE SECRETARY,
THE INSTITUTION OF PRODUCTION ENGINEERS,
10, CHESTERFIELD STREET,
LONDON, W.1.

I wish to attend the Materials Handling Conference which is to be held on Saturday, 23rd October, at the Works of John Wright & Company (Radiation) Limited, Aston, Birmingham, 6. Please send me a copy of the programme.

NAME..

GRADE..

ADDRESS..

....

NOTE: No acknowledgment will be made of this reservation. Programmes will be distributed as soon as possible.

Senior Jig and Tool Draughtsman required to act as checker in drawing office engaged in the tooling of heavy vehicle components. Permanent and pensionable post for right man. Apply: Transport Equipment (Thornycroft) Limited, Basingstoke, Hants.

Production Engineering Assistants with experience of batch production assembly of light and medium electro-mechanical apparatus required. H.N.C. or equivalent desirable. Contributory Pension scheme. Salary commensurate with qualifications and experience. Apply to: Personnel Superintendent, Westinghouse Brake & Signal Co. Ltd., Chippenham, Wilts.

Works Manager required with highest engineering qualifications and experience in complete control of large works. Age not over 40. Remuneration £1,400 in first year with substantial rapid promotion. Give full details of posts held and qualifications. Box No. 858, I.Prod.E., 10, Chesterfield Street, London, W.1.

Mechanical Engineer (Qualified) with management experience in progressive manufacturing works. Age not over 40. Remuneration rising from £1,400 to £2,000. Applications should give full details of qualifications and chronological details of posts held. Box No. 867, I.Prod.E., 10, Chesterfield Street, London, W.1.

Manufacturing or Methods Engineers and Product Development Engineers. Progress in manufacturing methods and techniques in connection with heavy rotating electrical machines and Mercury Arc Rectifiers have led to several interesting vacancies in The English Electric Co. Ltd., Stafford, for Manufacturing or Methods Engineers and Product Development Engineers. Applications are invited from engineers working in either of these capacities and from those who have a sound background of practical experience in a manufacturing industry, at least O.N.C. and a desire to enter either of these important branches of engineering. Please write quoting ref. 1225B to: Dep. C.P.S., 336/7, Strand, W.C.2.

Production Development Engineer. The English Electric Company Ltd., require a fully qualified Engineer at their Luton Works to take charge of a department responsible for carrying out investigation work into new methods of the manufacture in the light electro-mechanical field. The successful applicant will have sound practical training and possess a thorough knowledge of the latest manufacturing methods. This is a senior appointment, providing facilities for practical production research work, carrying a salary commensurate with the responsibilities involved, and with housing assistance if required. Applications, which will be treated in strict confidence, should be addressed to: Dept. C.P.S. Marconi House, 336/7, Strand, W.C.2. quoting ref: 900A.

Production Engineer required by progressive modern firm in the West Riding, manufacturing fast developing precision products associated with diesel engine trade. Must be able to work on own initiative and take charge of newly formed Production Engineering function. Applicants must have a thorough knowledge of production techniques on both British and Continental Turret, Capstan, Slotting, Milling and Drilling machines. The successful applicant will be required to apply modern work study techniques for the improvement of methods, lay-out and material handling, and to build up synthetic data for labour standards under the supervision of a management consultant. Please write, stating age, education, engineering experience and qualifications, positions held and salaries earned and required to:- Urwick, Orr & Partners Ltd., 28, East Parade, Leeds, Yorkshire, quoting reference FHP/1115.

Senior Production Staff. University graduates, aged between 28 and 40, who have had managerial experience in engineering and who are familiar with work study and modern production techniques, are invited to apply for positions on the Senior Production Staff of a large Midlands engineering company. The salary offered will depend on the experience and ability of the candidate but will be of the order of £1,500 - £2,500 per annum and there will be opportunities for further advancement. A good pension scheme is in operation. Applications will be treated in strict confidence and should contain full details of age, experience, technical qualifications and general education. Box No. 868, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Controller with proved administrative experience required for senior appointment, large engineering factory South West London. Bachelor of Science or equivalent. Write in the first instance for application form to: Personnel Manager, The Projectile & Engineering Co. Ltd., Acre Street, Battersea, S.W.8.

Estimator/Ratefixer required for leading heavy engineering works in North West area. Experience in plating, welding and machining for Pressure Vessels and general fabrications essential. Apply in writing, giving details of experience and salary required to: Box No. 869, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Engineer, capable of assuming charge of production control, required by leading firm engaged in heavy engineering in Glasgow area. Position offers scope for advancement in status and earnings. Commencing salary £1,200 p.a., Pension scheme, accident insurance and other benefits. Write Box No. 870, I.Prod.E., 10, Chesterfield Street, London, W.1.

Machine Tool Engineers. Cincinnati Milling Machines, Ltd., invite applications from men about 25 to 30 years of age with really first class engineering training both practical and technical and with exceptional natural ability. Successful applicants will be given opportunities to specialise in the Machine Tool industry. Apply in first instance by letter to: Woodlands Farm Road, Birmingham, 24.

Production Controller. A general engineering works in Yorkshire is appointing a senior executive to take charge of the production control department with responsibility for programming, loading, progressing and stock control. Applicants should be between 30 and 40 years of age; and preference will be given to those with an engineering degree. They should have had at least five years works organisation experience, and specialised training may be given. A four figure salary is envisaged for this appointment. Applications, which will be treated in strict confidence, to: Box No. 871, I.Prod.E., 10, Chesterfield Street, London, W.1.

Works Manager required for engine overhaul division. The applicant must have good technical qualifications and have had considerable experience of aircraft engine overhaul. He must have proven administrative ability and experience of material and stock control, progress, planning, and ratefixing. Preference will be given to an applicant with experience of British and American engines. Salary will be in the range of £1,250-£1,500 per annum, according to experience and qualifications. Apply: Personnel Manager, Field Aircraft Services, Ltd., Croydon Airport, Surrey.

Planning Engineers required by important North West Company occupying modern factory. Energetic men required with a sound knowledge of machining methods. Experience of Autos and Semi-Autos and/or assembly of medium weight machinery particularly desirable. Staff conditions, non-contributory pension scheme; salary level up to £800 per annum, housing available. Box No. 872, I.Prod.E., 10, Chesterfield Street, London, W.1.

Inspection Engineer. Excellent opportunity occurs in Birmingham for Production Engineer, or Jig and Tool Draughtsman with sound Engineering background to engage in responsible work on quality side of production, with progressive Motor Car Manufacturer. Permanent position, good salary, and real prospects for suitable man; state in confidence full particulars of career to date. Box No. 873, I.Prod.E., 10, Chesterfield Street, London, W.1.

Assistant Chief Inspector required for Factory manufacturing light precision products. Knowledge of Quality Control methods and organisation of modern inspection procedures for batch and flow production essential. The Company operates a contributory pension scheme and there are good prospects of promotion. Apply, with full particulars of age, education, training and experience with recent salaries earned to: Box No. 874, I.Prod.E., 10, Chesterfield Street, London, W.1.

Senior & Junior Machine Tool Draughtsmen wanted in South West London. Jig and Tool or Electrical Experience an advantage. A.E.S.D. rates and above paid to the right men. Excellent prospects and permanent positions. Write giving details in confidence to: Box No. 875, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Development Engineer required for Production Engineering Department of batch type production factory. Duties will include implementation of material handling schemes, preparation of factory layouts, and investigation into processing and machining problems. Education to H.N.C. preferred. The work should offer much interest and wide scope to a keen man with practical experience of similar problems in industry. Contributory pension scheme. Applications in writing, giving full personal, educational and industrial experience details, stating salary required and quoting reference number W/PDE2, to: Personnel Manager, Ferodo Limited, Chapel-en-le-Frith, *via* Stockport.

Experienced Estimator. Armstrong Siddeley Motors, Coventry, require the services of a fully experienced Estimator capable of working in conjunction with the Buying Department in cost estimating of new projects, etc. Applicants must have had considerable previous experience and should provide the fullest details of their qualifications and remuneration required. Apply to: Reference WAH.2, Personnel Manager, Armstrong Siddeley Motors, Parkside, Coventry.

Planning Engineer for Dowty Fuel Systems, Limited, Arle Court, Cheltenham, required. Candidates should be aged 25-30 and have practical experience. The position is a progressive one with the possibility of promotion to Assistant Production Engineer in the immediate future. Write in tabulated form to: Personnel Manager.

Consultant. C. G. Chantrill & Partners, Ltd., Industrial Consulting Engineers and Management Specialists, invite applications for the position of Consultants on their Production Engineering staff. Candidates should have a degree in engineering and have held a senior executive post in a large or medium industrial organisation, preferably engineering and allied trades. Salary commensurate with qualifications and experience. Applications, giving full particulars of qualifications, experience and personal details, should be submitted in writing to the firm's offices at National House, 14, Moorgate, London, E.C.2.

Chief Inspector. A light Engineering Company in the Nottingham area has a vacancy for the position of a Chief Inspector. Applicants should have experience of the manufacture of small metal pressings, and the assembly of Radio and Electrical components. Apply Box No. 876, I.Prod.E., 10, Chesterfield Street, London, W.1.

Works Manager. A keen and energetic man aged 35 to 45 with the ability to maintain a high level of output and foster good labour relations is required by a West Riding engineering company for the post of Works Manager. Applicants should preferably have experience of fabricated platework, machine shop and foundry production and methods. Knowledge of Work Study would be an advantage. Education should be up to Degree or Higher National standard. Reply, stating age, qualifications and present salary to Urwick, Orr & Partners, Ltd., 28, East Parade, Leeds 1, quoting reference No. BCH/1118.

Experimental Officers or Assistant Experimental Officers The Department of Scientific and Industrial Research require Experimental Officers or Assistant Experimental Officers at National Physical Laboratory, Teddington, on design of research equipment and instruments. Candidates should be able to produce designs to instructions and to follow them through the workshops. Qualifications: E.O. at least 26 with H.N.C. Engineering or equivalent; A.E.O. 18-22 with G.C.E. at advanced level in Scientific or mathematical subjects; over 22, H.N.C. in Engineering or equivalent. Prospects of permanent pensionable posts for E.O. under 31 and A.E.O. under 28. A 45½-hour week in the range E.O. (men) £741-£915 (women) £643-£782: A.E.O. (men) £298 (at age 18)—£664; (women) £298 (at age 18)—£561. Application forms from M.L.N.S. Technical and Scientific Register (K) 26, King Street, London, S.W.1., quoting reference C.442/54A. Closing date 14th August, 1954.

Time Study Engineer required by textile machinery manufacturers. Preferred minimum qualifications: O.N.C., full apprenticeship with practical experience in setting-up and operating machine tools. Age range: 25-35 years. Would be responsible for taking of time studies and the extraction of standard data therefrom for use of Ratefixing Staff. Non-contributory pension scheme. Applications should be made in writing stating, briefly, qualifications, experience and salary required to: Box No. 877, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Executive. Wilmot-Breeden, Limited, Amington Road, Birmingham 25. Applications invited for the above vacancy. Essential qualifications: (1) Member of Institution of Production Engineers or Electrical, Mechanical or Civil Engineers. (2) Management of a manufacturing department, or as Deputy Manager of a very large department or similar experience in H.M. Forces. (3) Experience in processing industries with experience of process controls, and of mechanisation of traditional operations. (4) Workshop training or apprenticeship desirable. The person appointed will be directly responsible to Chief Works Executive for one of a number of large departments. Position carries salary of executive grade with contributory and supplementary pension schemes. Applications in confidence marked "Production Executive" to R. S. Odd, Director and General Manager.

Chief Project Engineer. Wilmot-Breeden, Limited, Amington Road, Birmingham 25. Applications invited for the above vacancy. Essential qualifications: (1) Hons. University Degree or equivalent. (2) Three to five years as a resident and senior consultant on production engineering and allied work. (3) Three to five years as a Works or Production Manager, or Production Development Manager. The person appointed will be directly responsible to General Manager for direction and management of new department concerned with project evaluation, Product and Process Investigations and Plant Utilisation. Operation analysis either in project form or actual shop conditions. Position carries salary of Senior Executive (equivalent to Senior Consultant) with contributory and supplementary pension schemes. Applications in confidence marked "Chief Project Engineer" to R. S. Odd, Director and General Manager.

Production Manager required for production and development work on precision aero engine components. Applicant must be an experienced engineer, a strong disciplinarian and must have the drive and initiative necessary for high pressure production. Salary around £1,300 per annum. Apply in writing to Centrax Power Units, Ltd., Victoria Road, Feltham, Middlesex.

Production Engineers with considerable experience on precision engineering required to co-ordinate planning, tool design and production of aero engine components. Salary around £800 per annum. Apply in writing to Centrax Power Units, Ltd., Victoria Road, Feltham, Middlesex.

Qualified Engineer, Honours Degree or equivalent standard, with considerable experience in shop management, required. After suitable probationary period to take charge of quality control of firm engaged on high precision gas turbine components. Salary around £1,200 per annum. Apply in writing Centrax Power Units, Ltd., Victoria Road, Feltham, Middlesex.

Production Engineer or Mechanical Engineer. A prominent Sheffield Company require the services of a Production Engineer or Mechanical Engineer with production experience. Applicants should be University Graduates B.Sc. or equivalent standard with some practical industrial experience. Age 25 to 30 years. Applications with full particulars to British Acheson Electrodes, Ltd., Grange Mill Lane, Wincobank, Sheffield 9.

Methods Study Engineers. The Projectile & Engineering Co., Ltd., Acre Street, Battersea, S.W., are shortly opening a new Work Study department and require the following personnel. Methods Study Engineers, for medium and heavy machining. Methods Study Engineers for medium to heavy press work and fabricated assemblies. Materials Handling and Storage Engineers. It is essential that applicants should have previous experience in the category for which they apply. The age desired is not more than 35 and technical qualification necessary is O.N.C. certificate as minimum. The positions are progressive and pensionable. An application form for completion will be sent on request.

Senior Production Engineer Process Planning. Applications are invited from Production Engineers with considerable experience in process planning for appointment as Senior Production Engineer responsible for organisation and control of the Process Planning Department. Applicants should have served an engineering apprenticeship and have had at least ten years' experience as a planning engineer preferably with a large engineering company engaged in large and small batch production. The post calls for a specialist experience and knowledge of process planning on a wide range of machine tools. Applications giving full details of qualifications, experience, age and salary required to: Box No. 878, I.Prod.E., 10, Chesterfield Street, London, W.1.

Metallurgical Chemist. Competent young analyst required with knowledge of ferrous and non-ferrous analysis and the use of modern techniques. Excellent opportunity for carrying out interesting work connected with a variety of research and development projects. The position is permanent and progressive. Some knowledge of plating an advantage. Should have completed National Service. Superannuation scheme in operation. Send full details, including salary required, to: Box No. 879, I.Prod.E., 10, Chesterfield Street, London, W.1.

Research Metallurgist, with good degree and experience is required to undertake work on problems associated with machining and forming of ferrous and non-ferrous materials. Knowledge of the cold working of metals would be an advantage. Surroundings are pleasant and the successful candidate will be working in interesting fields which offer wide scope. The position is permanent and progressive and carries F.S.S.U. benefits. Full details, including age, experience, qualifications and salary required to: Box No. 880, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production and Methods Engineer required to head up expanding Time and Method Study department. Applicant should have an engineering degree or equivalent and training in lay-out, time and method study and production organisation. Some experience of chemical plant would be an advantage. A four figure salary is envisaged. The post is pensionable and there is a Staff Profit Participation scheme. Write in confidence giving fullest details of education, training, experience, age and salary required to: Personnel Manager, County Laboratories Limited, Honeypot Lane, Stanmore, Middlesex.

Methods Development Engineer required for improving assembly and machine shop methods in a precision engineering works. Applicants must have experience of batch flow line production methods, covering all types of machine tools. Must be prepared to introduce, demonstrate and follow through new manufacturing techniques. Applications giving full details of age, experience, qualifications and salary required to: Towler Bros. (Patents) Ltd., Rodley, Leeds.

Superintendent required for progressive North West light engineering company. Must be good disciplinarian and used to short and medium batch production on high precision work. Four figure salary and good prospects of advancement for energetic man with theoretical qualifications not less than H.N.C. Apply: Box No. 881, I.Prod.E., 10, Chesterfield Street, London, W.1.

Senior Engineer. Engineering firm in S.E. London engaged in plate work fabrication, with special emphasis on heavy chemical plant, requires a Senior Engineer, aged 30 - 45 years. Applicant should have a sound knowledge of modern engineering practice with some executive experience. Applicants should apply, stating age, experience and salary required to: Box No. 882, I.Prod.E., 10, Chesterfield Street, London, W.1.

Assistant Works Manager required with all round practical workshop training and experience with responsibility: Institution membership and/or engineering degree preferred: age say 25 - 30 years: The progressive position to be filled is with a long established engineering concern in the Manchester area producing medium weight precision machines of specialised types: 160 to 200 employees: give full particulars with indication of salary required to: Box No. 883, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Engineer-Draughtsman required by Minimax Limited, Staines Road, Feltham, Middlesex. Excellent opportunity to build up own department covering design of product, factory layout, tooling and research. Good salary. Apply in writing in the first instance.

Work Study Officer with engineering training required for the British Productivity Council's Work Study Unit. Must be an experienced work study practitioner, preferably with a background of consultancy. Ability to address varied audiences essential, and some knowledge of the running of work study training courses an advantage. Salary according to qualifications and experience. Applications giving, on separate sheet, full details of age, education, experience, etc. in chronological order to: Secretary, BPC, 21, Tothill Street, London, S.W.1.

Senior Work Study and Methods Engineer required to take charge of an expanding department. Experience in light engineering, including press work, pressure casting, injection moulding, painting, conveyor assembly an advantage. Excellent opportunity for energetic and efficient man. Applications stating experience, age, salary range, should be sent in confidence to: the Secretary, Mettoy Co. Limited, Fforestfach, Trading Estate, Swansea.

Time Study Observers required, preferably with light engineering background. Would consider trainees with suitable qualifications. Permanent positions with chance of promotion. Apply giving full details of experience, age, salary requirements, to: the Secretary, Mettoy Co. Ltd., Fforestfach, Trading Estate, Swansea.

Chief Engineer and Technical Adviser. Applications are invited for the post of Chief Engineer and Technical Adviser to a large firm of Dyers in the Midlands. The successful applicant will be directly responsible to the Board and will be primarily concerned with the organisation of maintenance including in particular Water Tube Boilers and back pressure Turbines. Age 35/45. Remuneration of the order of £2,000 per annum. Pension scheme. Box No. 884, I.Prod.E., 10, Chesterfield Street, London, W.1.

FIFTH ANNUAL GRADUATE CONFERENCE

The Fifth Annual Graduate Conference will be convened by the Wolverhampton Graduate Section in March, 1955. Further details will be announced later.

REFRESHER COURSE FOR WORKS AND PLANT ENGINEERS

It is announced by the Regional Council for Further Education for the South West, in collaboration with the Bristol Education Committee, that a residential refresher course for Works and Plant Engineers will be held at Wills Hall, University of Bristol, from 6th/11th September, 1954.

Lectures will be given by national experts, dealing with boiler plant, power generation, plant processes, space heating and air conditioning, and opportunity will be given for visits to industrial concerns, and for group discussion.

The Course fee, to include lectures, visits and synopses of lectures, is three guineas, and the residential fee, to include accommodation and meals, is six guineas. Application forms and a brochure giving full details of speakers and lecture contents, may be obtained from the Regional Council at 12, Lower Castle Street, Bristol, 1.

COVENTRY ANNUAL DINNER DANCE

The Coventry Section are holding their Annual Dinner Dance on Friday, 15th October, 1954, at the Matrix Hall, Fletchamstead Highway, Coventry. The reception will be at 7.30 p.m., for Dinner at 8 p.m., and there will be dancing until 2 a.m.

Tickets may be obtained, price 25/- each, from Mr. W. P. Gill, c/o S. Gill & Sons (Engrs.) Ltd., Lythalls Lane, Coventry.

PRODUCTION APPOINTMENTS

BULLETIN No. 47

This bulletin is circulated to all members of the Institution monthly as near as possible to the first of the month. Firms or organisations wishing to insert notices in the bulletin should communicate with the Secretary at 10, Chesterfield Street, London, W.1.

The last date for receiving material for insertion in the following month's bulletin is the 20th of each month.

The fee for insertion of particulars regarding each appointment is £3 3s. (up to 100 words), and over 100 words £5 5s. No charge is made to firms affiliated to the Institution, Technical Colleges, Universities and similar organisations.

Advertisers are advised that better response is likely if, in addition to essential qualifications, the following information is given :-
(*a*) Location of appointment; (*b*) Status in the organisation and scope of promotion; (*c*) Salary range and age range.

Advertisers are asked to advise the Institution when vacant appointments are filled. The Institution reserves the right to refuse or withdraw any announcement and also to make any alteration in the wording to ensure conformity with Institution standards.

Members interested in the following appointments should make application in accordance with the terms of notice. No correspondence can be undertaken by the Secretary other than the forwarding of replies to Box Nos.

Production Engineers with versatile experience in Methods Planning, Press tools, Jigs and fixture and gauge design, also design of special machines. Confident and competent to control assistant executives and staff. Ability to negotiate with customers at top level. The positions are permanent, and salary commensurate with responsibilities. Applicants must be between age 30 - 35 and possess previous experience in similar position. Qualified A.M.I.Mech.E. and/or A.M.I.Prod.E. Successful applicant will receive Directorship after first year's service. Locations, Midlands and West of England. Applicants must state details of career and salaries to date. Box No. 834, I.Prod.E., 10, Chesterfield Street, London, W.1.

Production Manager (35-45) required by well-established and expanding light engineering company in Midlands, comprising group of factories each specialising in different product and involving mass and batch production. First class practical and technical qualifications essential (at least H.N.C.) with wide managerial experience in light engineering. Excellent promotional opportunities for man of character, energy and ability. Very substantial salary, according to qualifications and experience, with participation in generous superannuation, life assurance and bonus schemes. Applications marked "Attention of Production Director" must give full details of qualifications, positions held and age. Box No. 847, I.Prod.E., 10, Chesterfield Street, London, W.1.

FIRST YORKSHIRE REGIONAL WEEKEND SCHOOL

The first Yorkshire Regional Weekend School, convened by the Region Graduate Sections, will be held at Craiglands Hotel, Ilkley, on 18th and 19th September, 1954. The theme of "Cheaper Production" has been selected in view of the national importance of ensuring more economical production, and the programme is arranged to bring forward some of the applications of Scientific Management.

Saturday, 18th September.

11.30 a.m.
Reception.

2 p.m. - 4 p.m.
"Budgetary Control and Standard Costs".
Speaker: F. H. Pritchett, Esq. (Urwick, Orr & Partners, Ltd.) (followed by discussion).

4 p.m. - 4.30 p.m.
Tea.

4.30 p.m. - 6.30 p.m.
"Some Applications of Work Study".
Speaker: B. C. Hilton, Esq. (Urwick, Orr & Partners, Ltd.) (followed by discussion).

7 p.m.
Dinner.

Sunday, 19th September.

10 a.m. - 12.30 p.m.
Discussion of a Test Case, arranged by B. C. Hilton, Esq.

1 p.m.
Luncheon.

2 p.m.
Summing Up.

The fee for the School will be £2. 5. 0., which includes accommodation and meals from tea on Saturday to luncheon on Sunday, inclusive. Accommodation can be arranged for ladies at the same charge, and non-members of the Institution are cordially invited to attend. Applications should be made on the form below.

YORKSHIRE REGIONAL WEEKEND SCHOOL

To: G. Harrison, Stud.I.Prod.E.,
5, Myrtle Grove,
Quarmby,
Huddersfield.

I wish to attend the Weekend School and I shall/shall not require accommodation at the Hotel. I shall be accompanied by M..............................and shall require a single/double room.

I shall/shall not require Dinner at the Hotel on Saturday.

Please find enclosed cheque for £..............,made payable to you.

NAME..

GRADE..

ADDRESS..

....

Production Engineer (Sales), required by well known lathe chuck manufacturers to undertake field sales and service on recently developed Power Chucking Equipment. Good knowledge and experience of modern production turning and latest machine tool design essential. Substantial salary. Headquarters in London area, but position necessitates travel throughout the country. Apply giving full particulars of age, education, training and experience to: Box No. 885, I.Prod.E., 10, Chesterfield Street, London, W.1.

Engineers. Applications are invited from engineers for permanent progressive positions on work connected with research and development of engineering production processes. Candidates should possess a degree or Higher National Certificate in mechanical engineering. There are excellent prospects of advancement for successful applicants. Superannuation scheme in operation. Send full details including salary required to Box No. 886, I.Prod.E., 10, Chesterfield Street, London, W.1.

EDUCATIONAL APPOINTMENTS

Hackney Technical College.
Assistant Grade B.
Assistant Grade B, preferably with degree or equivalent, to teach mechanical engineering subjects to Final C & G Machine Shop Engineering standard, and engineering drawing to S.2. O.N.C. standard. Ability to assist in theoretical and practical classes for Motor Vehicle Service Mechanic's National Craftsman's Certificate an advantage. Salary within Burnham (F.E.) scale £526 - £927. Commencing and maximum salary according to qualifications and experience. Application forms from Secretary at College, Dalston Lane, E.8. Closing date 23rd August.

Hatfield Technical College.
Assistant Grade B.
Applications are invited for an Assistant Grade B to commence duties on the 1st September, 1954 in the Works and Production Engineering Department of the College. Applicants should be corporate members of a senior institution and be capable of teaching to National Certificate level in Mechanical Engineering classes.

Salary will be on the Burnham Technical Scale Grade B according to qualifications and experience.

Forms of application can be obtained from the Registrar, (Ref. WP) Hatfield Technical College, Roe Green, Hatfield, Herts, to whom completed forms should be returned as soon as possible.

The Royal Technical College, Glasgow.
Department of Industrial Administration.
Work Study Demonstrator.
Applications are invited from men with industrial experience for the post of Work Study Demonstrator to develop the laboratory side of Work Study Courses. The duties will involve the design and construction of models and experimental layouts, the preparation of slides, wall-charts and similar teaching aids, the supervision of students' work on charting and rating, and lecture-demonstrations. Ability to take cinema films, select and prepare film-loops for analysis would be an advantage. The salary will be on the scale £500 x £25 - £700, and the starting salary will depend on qualifications and experience. Applicants should be fully trained in work study, and should preferably have had experience in different industries and types of production. Forms of applications may be obtained from the Secretary, George Street, C.1.

B to com-
Works and
ge. Appli-
institution
icate level

e Grade B

Registrar,
, Hatfield,
ed as soon

experience
evelop the
duties will
s and ex-
wall-charts
ents' work
is. Ability
for analy-
n the scale
depend on
d be fully
have had
production.
Secretary,